PB82-190224

Draft Environmental Impact Statement City of Los Angeles Wastewater Facilities Plan Chapters III, IV, V, and VI

Los Angeles City Dept. of Public Works, CA

Prepared for

Environmental Protection Agency
San Francisco, CA

Sep 77

U.S. Department of Commerce
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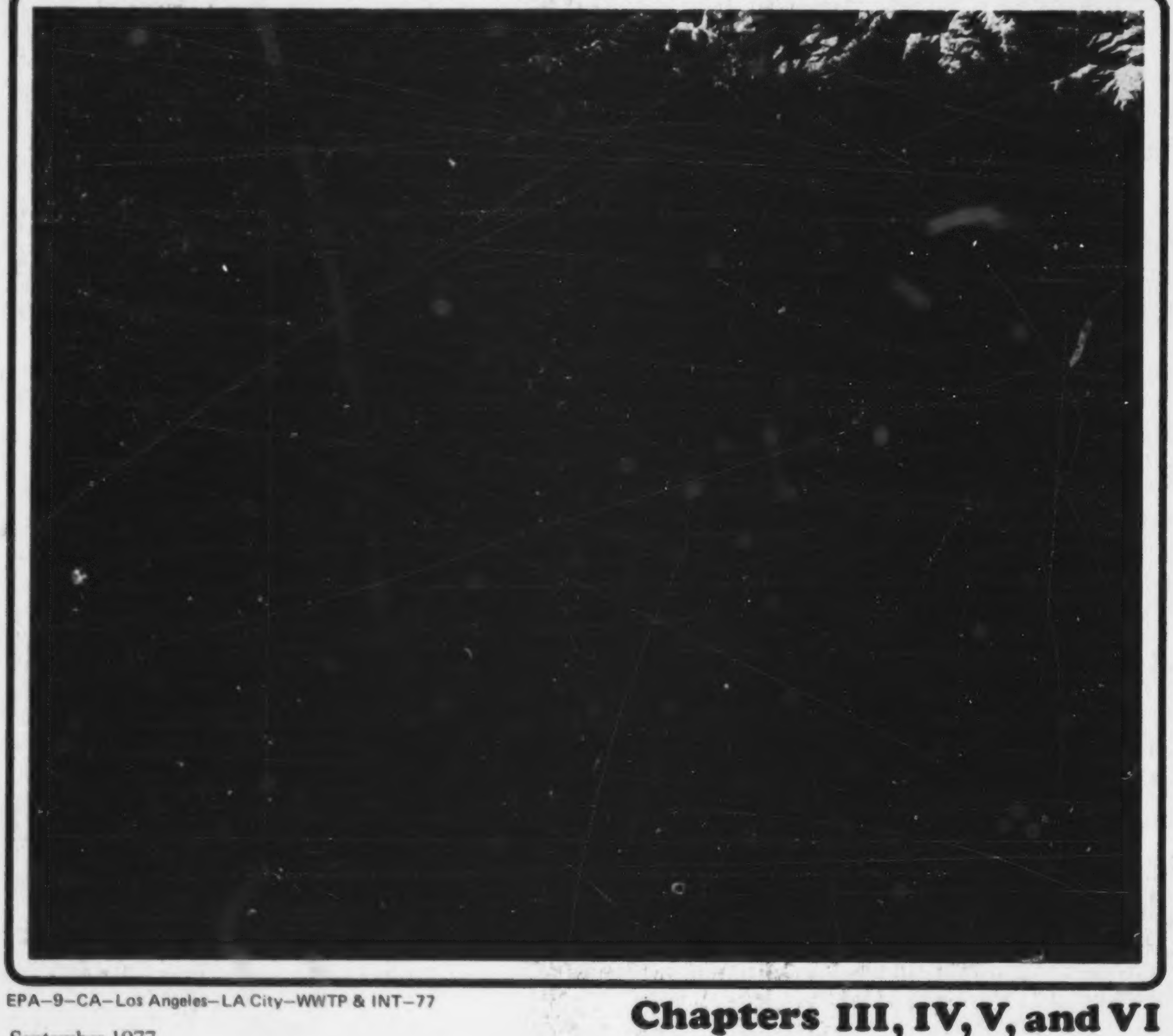

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The study is a review of the Draft Environmental Impact Statement/Environmental Impact Report for the City of Los Angeles Wastewater Treatment Facilities Plan. The EIS/EIR summary and full report present the environmental, economic and social effects of wastewater facility planning decisions which will affect over 3.4 million persons living in the City of Los Angeles. The main purpose of this document is to publicize the long range environmental and social effects of wastewater facility alternatives so that citizens and governmental agencies can comment and express their concerns and preferences.

KEYWORDS: *Sludge disposal, *Sewage disposal, *Environmental impact statements-draft, *Ocean waste disposal, *Los Angeles(California).

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ENVIRONMENTAL IMPACT STATEMENT CITY OF LOS ANGELES WASTEWATER FACILITIES PLAN

September 1977

Chapters III, IV, V, and VI

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
100 CALIFORNIA STREET
SAN FRANCISCO, CALIFORNIA 94111

SEP 01 1977

To All Interested Agencies, Public Groups, and Concerned Individuals:

The study is a review of

We submit for your review and comment the Draft Environmental Impact Statement/Environmental Impact Report for the City of Los Angeles Wastewater Treatment Facilities Plan. This statement has been prepared in compliance with the National Environmental Policy Act of 1969 (P.L. 91-190), and implementing regulations promulgated by the Council on Environmental Quality and the Environmental Protection Agency. It has also been prepared in compliance with the California Environmental Quality Act and its implementing regulations.

The EIS/EIR summary and full report present the environmental, economic and social effects of wastewater facility planning decisions which will affect over 3.4 million persons living in the City of Los Angeles and contract cities, and involve capital costs in excess of 300 million dollars over the next five years.

The main purpose of this document is to publicize the long range environmental and social effects of wastewater facility alternatives so that citizens and governmental agencies can comment and express their concerns and preferences. Public comments are expected to play a key role in (1) selection of long-range alternatives for the service area, including size and location of collection and treatment facilities, and (2) implementation of measures needed to reduce adverse environmental effects.

The Environmental Protection Agency, Region IX and the City of Los Angeles, Bureau of Engineering will hold hearings on the Draft EIS, approximately 30 days following the distribution of the EIS. The exact place and date will be announced. All interested parties are invited to express their views at the hearings. Persons wishing to make comments may submit them in writing and/or appear at the hearings. Oral statements will be considered, but, for the record, all important testimony should be submitted to:

Environmental Protection Agency, Region IX
Attn: Fred Krieger, W-1
100 California Street
San Francisco CA 94111

Enough copies of the written material should be provided so that other interested parties at the hearing may receive a copy. Oral statements should summarize extensive written material since it is necessary for all interested parties to be heard. After the public hearings the Draft EIS/EIR will be revised in light of the comments to form the Final EIS/EIR.

If you do not comment at the public hearings, you may send written comments to EPA at the address given above within thirty days following the hearings.

The following documents constitute the EIS:

Mini-Summary
General Summary
Main text (3 volumes)
Addendum 1. Reclamation Options
Addendum 2. Environmental Analysis of Reclamation
Addendum 3. Interim Sludge Processing and Disposal System
Appendices

Copies of these documents can be obtained by written or by telephone requests at the address given above or at:

City of Los Angeles, Bureau of Engineering
City Hall East-Room 650
200 North Main Street
Los Angeles CA 90012 Attn: Fred Hoeptner
(213)485-3089

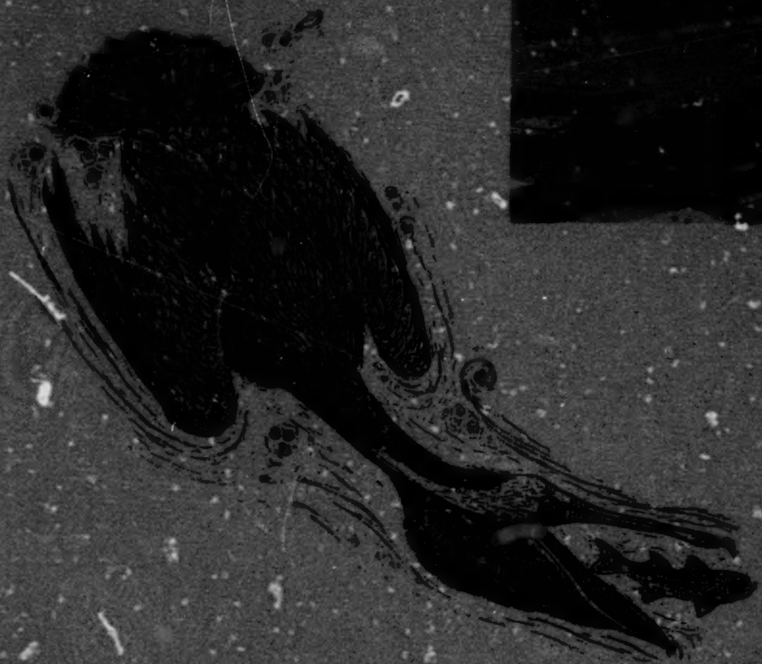
Additionally the Draft EIS and supplemental information may be reviewed at the above addresses or at the public libraries within the service area of the City of Los Angeles.

Please bring this notice to the attention of all persons who would be interested in this matter.

Sincerely,

Sheila M. Prindiville
for Paul De Falco, Jr.
Regional Administrator

100P-223



Chapter III

description of environmental setting- marine environment

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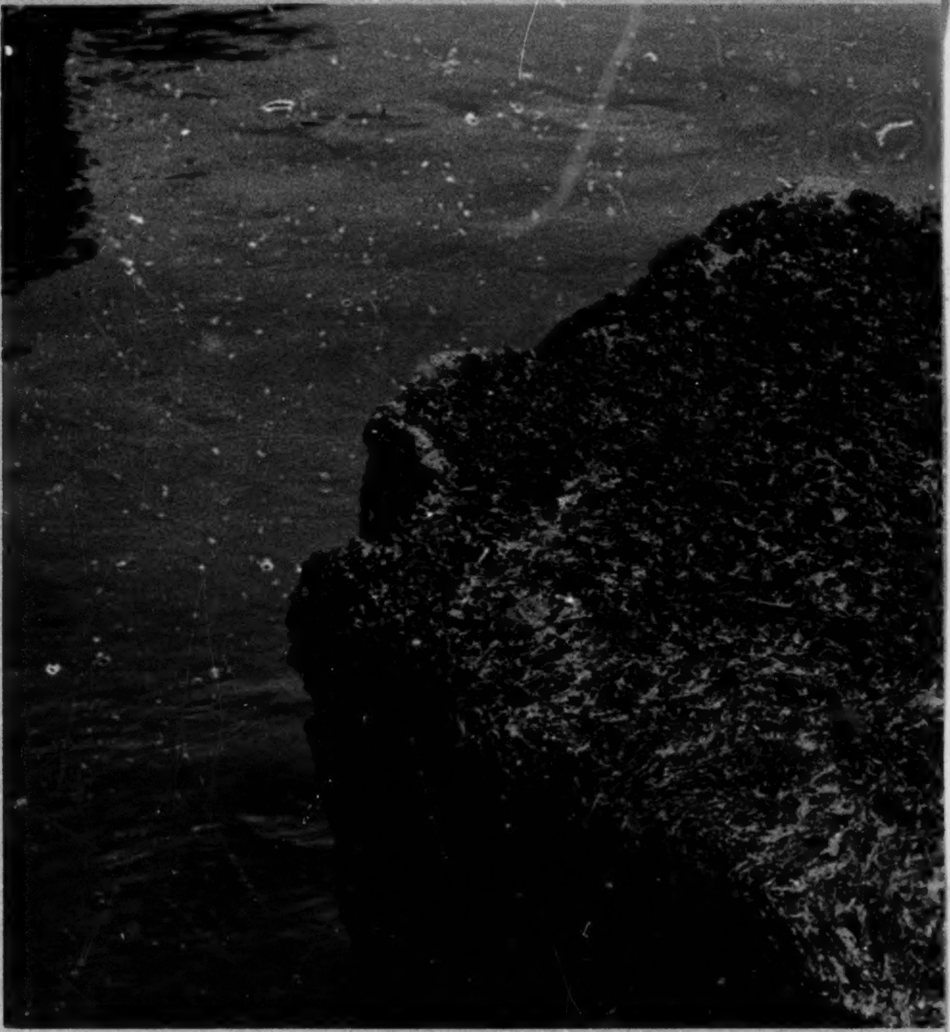

198P-224

A. physical oceanography

A. PHYSICAL OCEANOGRAPHY

1. PHYSICAL LAYOUT

The seafloor topography of the California marine borderland is of unusual relief due, in part, to extensive modification by submarine erosional processes. The coastal shelf in the Santa Monica and San Pedro area is relatively narrow, and, in some places, water 300 feet deep may occur less than one mile from shore (on Figure III-A-1). The deepest nearshore waters are at the head of submarine canyons. There is a pronounced flattening of the seafloor at the 2400-foot depth contour which may vary from as close as four miles from shore to as far out as 20 miles. Shoreward from the 300-foot depth contour, the seafloor is usually quite flat and featureless.

The Southern California Bight is the open embayment of the Pacific Ocean, approximately 300 miles long and 125 miles wide, extending from Point Conception on the north to Cabo Colnett, Baja California, on the south. Its western boundary is roughly defined by the California Current and the continental slope of southern California at a depth of 10,000 feet.

Santa Monica Bay(Figure III-A-2) extends from Point Dume on the northwest to Palos Verdes Point on the southeast, an airline distance of 24 miles with an indentation of approximately seven miles. The bay floor is fairly flat and slopes very gently in the westerly direction out to a depth of 300 feet where the slope abruptly steepens to a depth of 2,400 feet.

The bay shelf is traversed by two well-developed submarine canyons, Santa Monica Canyon and Redondo Canyon. The head of Santa Monica Canyon originates about 4-1/2 nautical miles southwest of Santa Monica, and the canyon extends almost due west to a depth of 2,400 feet. The Hyperion sludge line discharges near the head of this canyon. The head of Redondo Canyon originates just a few yards offshore at Redondo Beach, and this canyon extends slightly south of west for about 8 nautical miles to a depth of 1,800 feet.

San Pedro Bay (Figure III-A-1) extends from Point Fermin at the southern end of the Palos Verdes Peninsula eastward to the vicinity of Seal Beach, an area approximately 12 miles long by 7 miles wide. The bay floor is flat, sandy, and gently sloping to the southwest except for the man-made harbor structures of the ports of Los Angeles and Long Beach. The outer boundary of the bay is at approximately 50 feet below sea level.

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The harbor complex has been built around a detached barrier beach now called Terminal Island. The entire complex is protected by a 9-mile long rock breakwater constructed along approximately the 50-foot depth contour. The harbor is divided into outer and inner portions. The outer harbor is the area between the breakwater and the shoreline, and the inner harbor is comprised of the channels surrounding Terminal Island. Depths in the outer harbor typically range from 15 to 50 feet while depths in the inner harbor are typically in the vicinity of 35 feet. These depths will be modified if plans currently being developed for dredging of new channels and construction of new dry areas within the harbor system are implemented.

2. CURRENTS, CIRCULATION, ADVECTION, AND UPWELLING

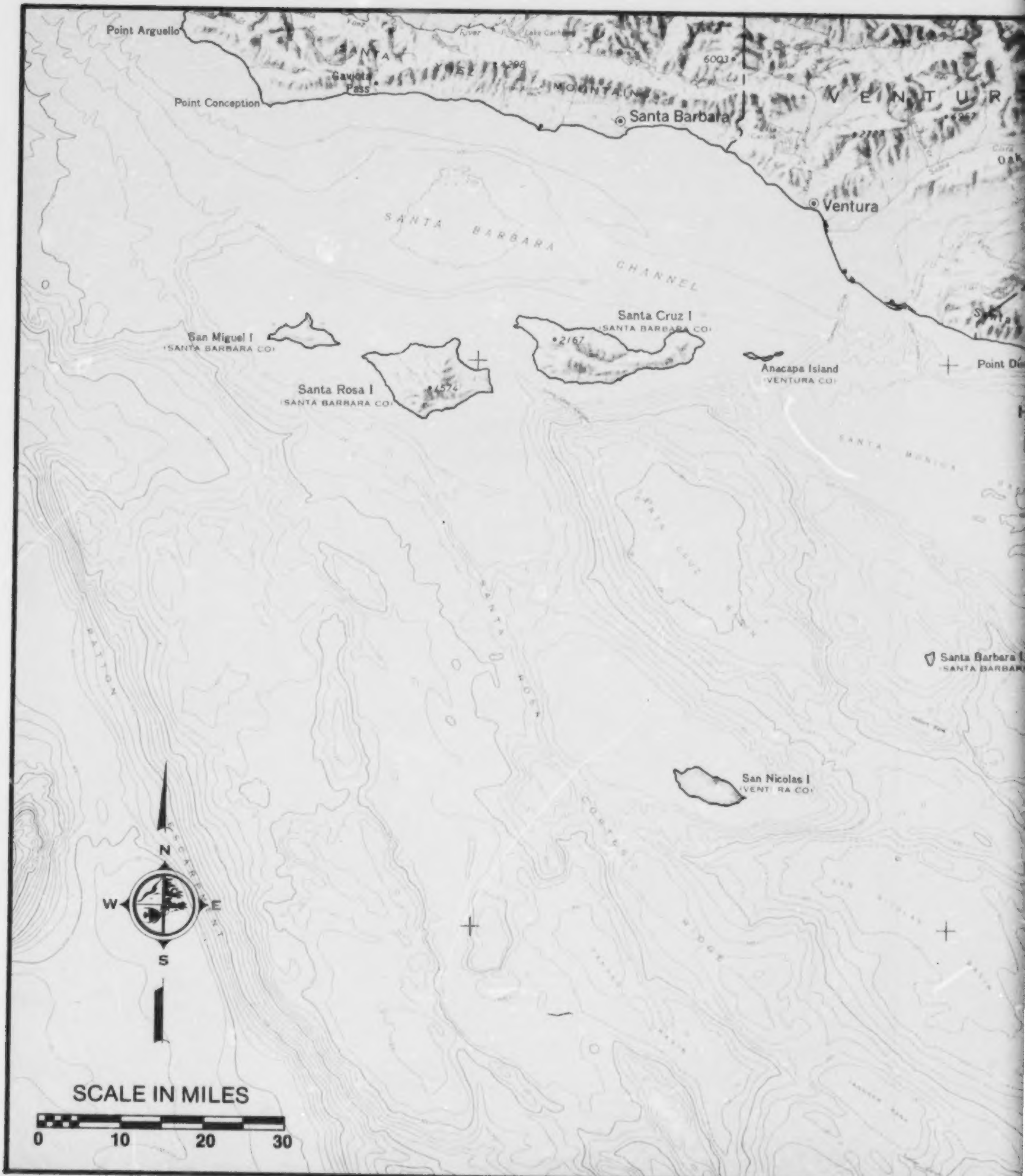
Knowledge of the nearshore current dynamics, both long and short-term, are necessary for predicting residence time and dispersion of point source discharges into the Southern California Bight. Although data on the complex current velocities (speed and direction) throughout the Bight are incomplete, available information suggests that considerable seasonal and annual variation occurs as a result of prevailing winds, the earth's rotation, and solar heating.

The major current in southern California waters is the California Current, a wide southeastward-moving current that passes along the offshore border of the Southern California Bight (Figure III-A-3). This is a weak current that varies greatly in velocity from year to year and with the seasons and is at its weakest during winter and spring.

A portion of the California Current turns eastward off the coast of Baja California and then northwestward into the Southern California Bight. This current is known as the Southern California Countercurrent. North of Santa Barbara Island, a portion of the Countercurrent is then deflected eastward and southward along the coast. During late winter and spring, winds that blow southeasterly along the coast enhance this southward moving coastal current. Typically, such southward moving currents along a western coast are deflected to the west.

From November to February and before the onslaught of prevailing northwesterly winds, a surface current may become established flowing northwestward along the coast from south of San Diego to north of Point Conception. This inshore, seasonal flow is known as the Davidson Current. A deeper northward-moving current, the California Undercurrent, is also present in the Southern California Bight (Figure III-A-4).

During most of the rest of the year, the south-setting coastal current induces a slow counterclockwise eddy within northern Santa Monica Bay. When this coastal current is relatively weak, the onshore winds and the Davidson Current tend to push water into the Bay, resulting in a weak north to south longshore movement. These currents are extremely variable, and currents with durations of a week or longer act to flush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Santa Cruz I
SANTA BARBARA CO
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Anacapa Island
VENTURA CO
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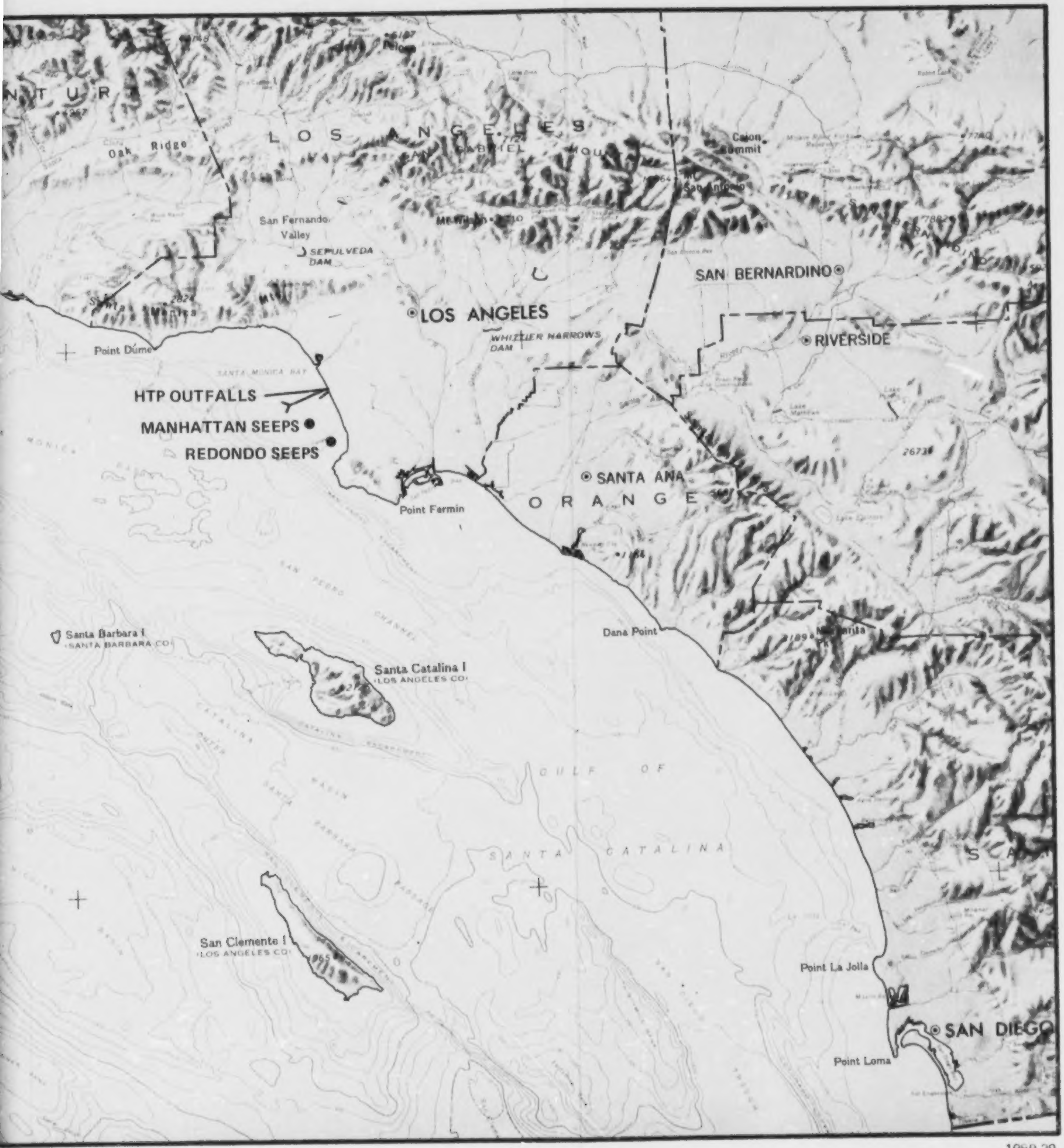
Figure III-A-1. Base map showing general features of the submarine topography in the vicinity of Santa Monica Bay and San Pedro Bay. The Hyperion Treatment Plant outfalls and Manhattan and Redondo oil deeps are also shown. Depths are in fathoms.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LOS ANGELES
WHITTIER NARROWS DAM
RIVERSIDE
Point Dume
SANTA MONICA BAY
HTP OUTFALLS
MANHATTAN SEEPS
REDONDO SEEPS
Point Fermin
SANTA ANA
ORANGE
SAN PEDRO CHANNEL
Dana Point
Santa Barbara I
SANTA BARBARA CO
Santa Catalina I
LOS ANGELES CO
GULF OF SANTA CATALINA
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LOS ANGELES CO
Point La Jolla
SAN DIEGO
Point Loma

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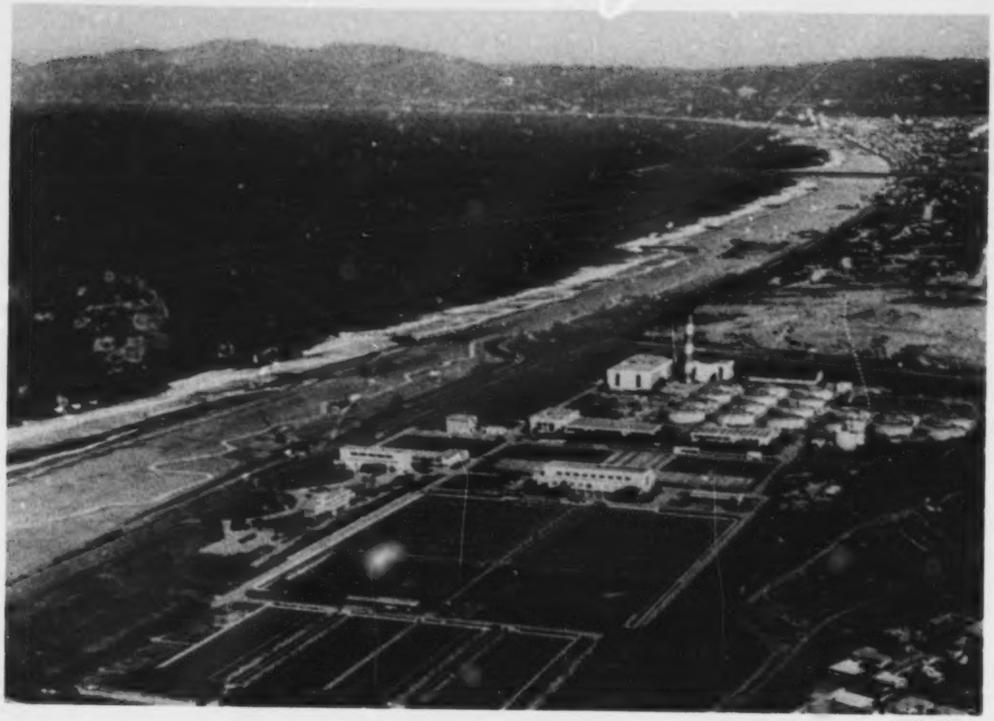

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Figure III-A-2. Santa Monica Bay, with an airline distance of 24 miles and an indentation of approximately seven miles, has a fairly flat floor that slopes gently in the westerly direction to a depth of 300 feet and then slopes abruptly to a depth of 2,400 feet. Note the location of Hyperion Treatment Plant in the foreground.

water out of Santa Monica Bay. The presence of currents with shorter tidal periodicities has long been recognized, but it is the long duration flows which provide a more effective mechanism for flushing (SCCWRP, 1975a).

Current measurements of the general depth of submerged wastefields were made recently by SCCWRP at nine locations from Santa Barbara to Point Loma. The mean current speed for observation periods of 7 to 226 days at a depth of 41 m (in 56 m of water) was 9.8 cm/sec (mean range 7.1 to 11.2 cm/sec) for the Bight, and the mean velocity at each location measured varied less than 20 percent from the Bight average (SCCWRP, 1976). The predominant direction of these currents is alongshore, that is, along the constant depth contours. In Santa Monica Canyon, the current speed averaged 7.1 cm/sec over a 22-day period with a maximum

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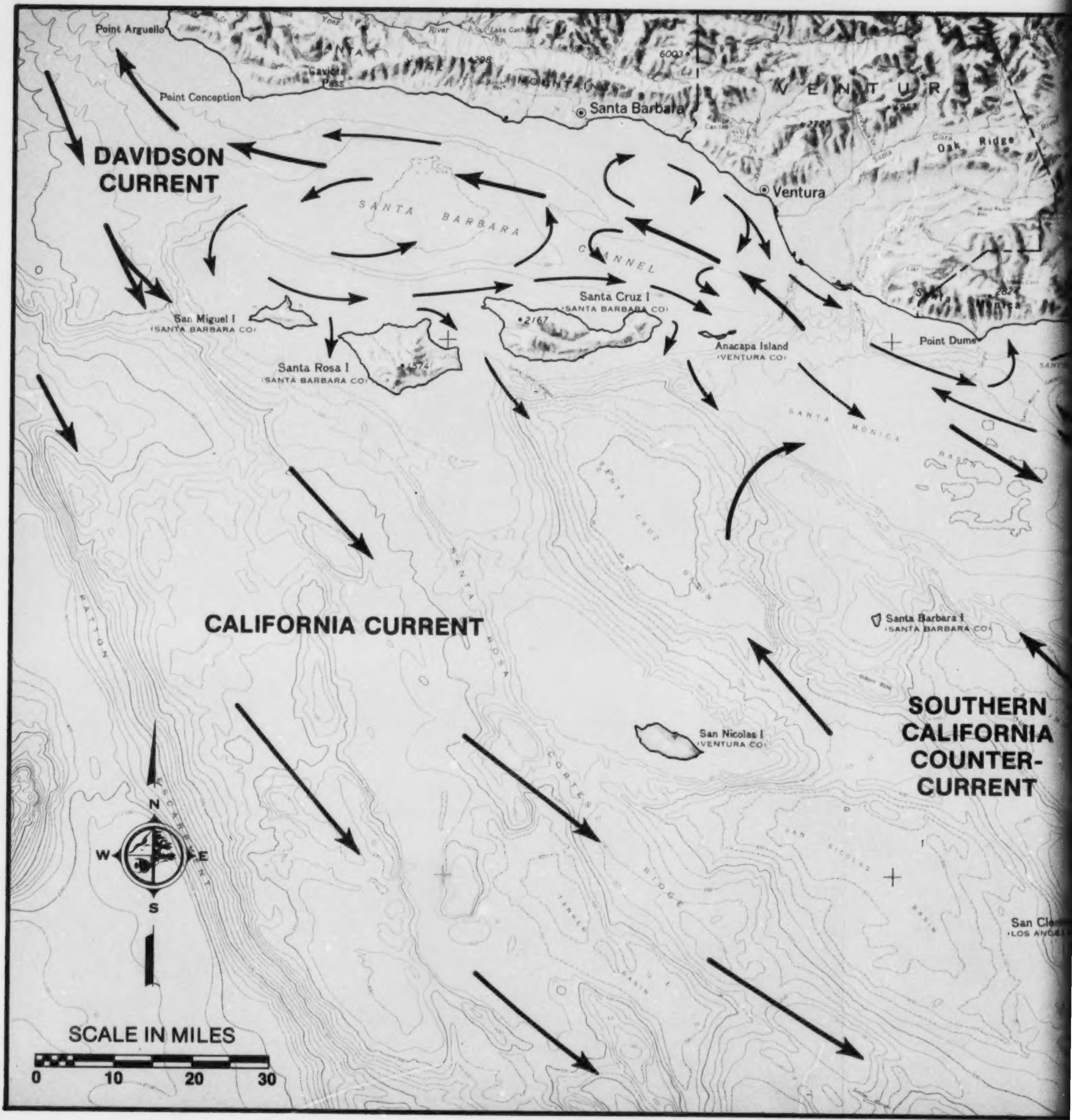
speed of 22 cm/sec (SCCWRP, 1976). If the prevailing currents passing the HTP outfall were assumed to be unidirectional, parallel to shore, and flowing at a mean rate of 7.1 cm/sec, it would take approximately three days for effluent leaving the outfall to be transported from the Bay. Doubling the mean current rate would halve the transport time. The net nontidal current, however, may fluctuate greatly at different locations in the Bay and times of the year. Moreover, under certain conditions, onshore winds and eddies tangent to either the nearshore Davidson or California Currents may recirculate the wastefield in the Bay so that effluent constituents may actually accumulate rather than being dispersed. The probability of such "stagnation" conditions occurring, however, apparently has not been estimated from reliable data. Long-term plume measurements or modeling might be useful in examining such situations and more information on the seasonal current patterns of the Bay may be necessary as well.

These major currents circulating in the Bight serve to transport suspended and dissolved substances throughout the Bight, and indeed, throughout the Pacific Ocean in a horizontal mass transfer process sometimes referred to as advection. Thus, substances entering the ocean in Santa Monica Bay and San Pedro Bay may eventually be distributed throughout the Pacific. Likewise, substances entering the ocean elsewhere in the Pacific can be transported to these bays. It is the major currents and their eddies that cause most of the mass transport along the southern California coast and in Santa Monica Bay. Onshore-offshore currents are considered important by some authorities only in a few areas or under certain transitory conditions such as occurrences of offshore winds during winter months (SCCWRP, 1975a).

Onshore-offshore transport is best studied by following the distribution of substances introduced into the water offshore. Section III.B.2 shows some examples of the seasonal distribution of coliform bacteria introduced 5 and 7 miles offshore in Santa Monica Bay by the Hyperion Treatment Plant outfalls. Studies have also been conducted using light transmisometers, and the data from these studies will become available soon (Kolpack, 2 March 1977).

In San Pedro Bay the onshore-offshore tidal currents are much more important than in Santa Monica Bay in the transfer of substances between the ocean and the bay because most of San Pedro Bay is enclosed within the Nine-Mile Breakwater (see Figure III-A-5) which severely limits the entrance of currents to the Bay. Tidal currents provide the major flushing action, and Figure III-A-5 shows typical currents during an incoming (flood) tide. Current speeds reach 0.8 to 1.0 knots.

In the northern hemisphere, prolonged periods of northwesterly winds blowing parallel to the west coast cause a net movement of nearshore surface waters toward the open ocean. When this occurs, as it occasionally does off southern California between late winter and early spring, the displaced surface water is replaced by a mass of deep nutrient-rich water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PATTON ESCARPMENT
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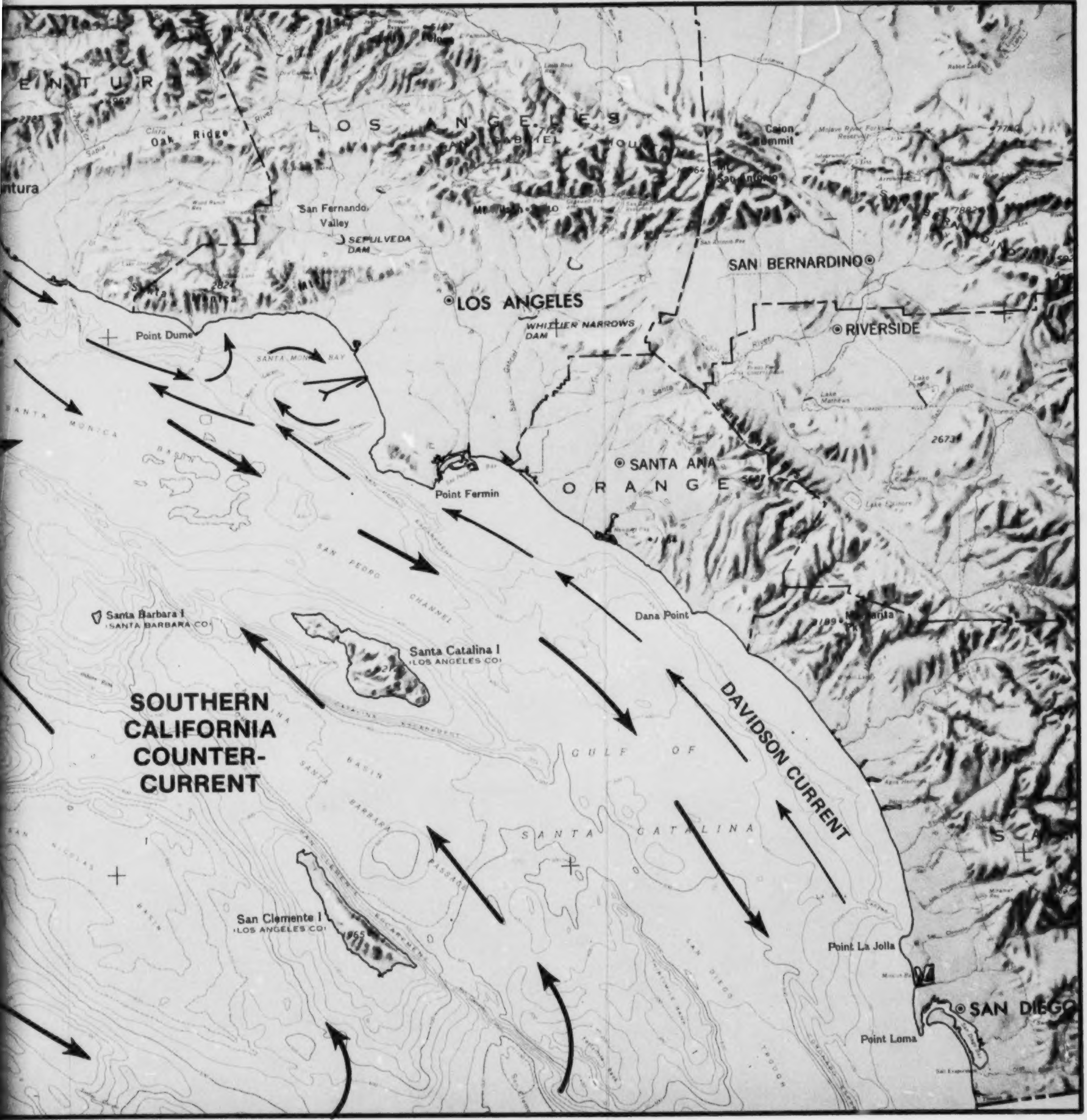
Figure III-A-3. Surface circulation (0 to 100 m) in the Southern California Bight. The arrows indicate the approximate direction of flow. Depths are in fathoms (from Jones, 1971; Straughan, 1976).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LOS ANGELES
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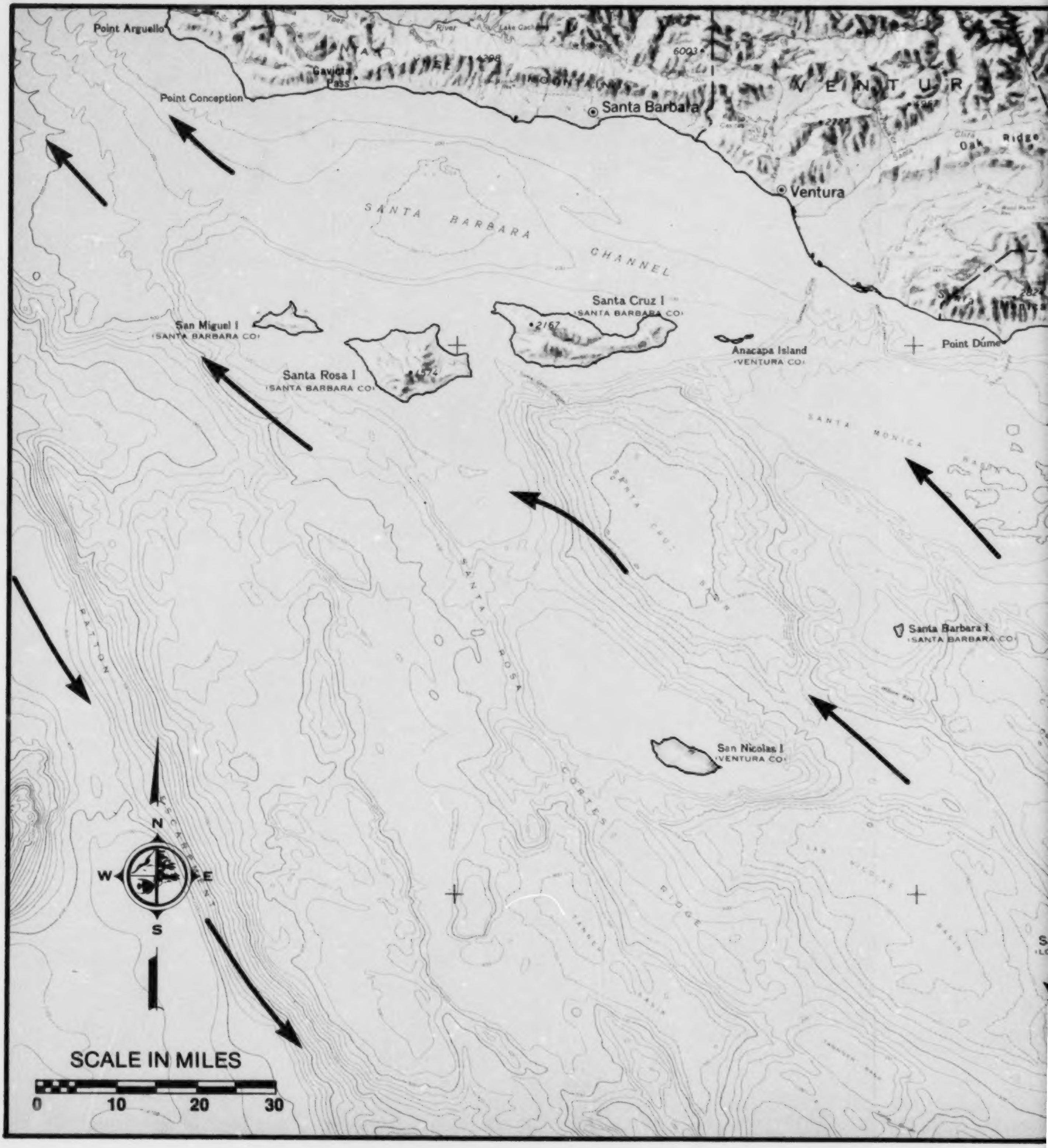
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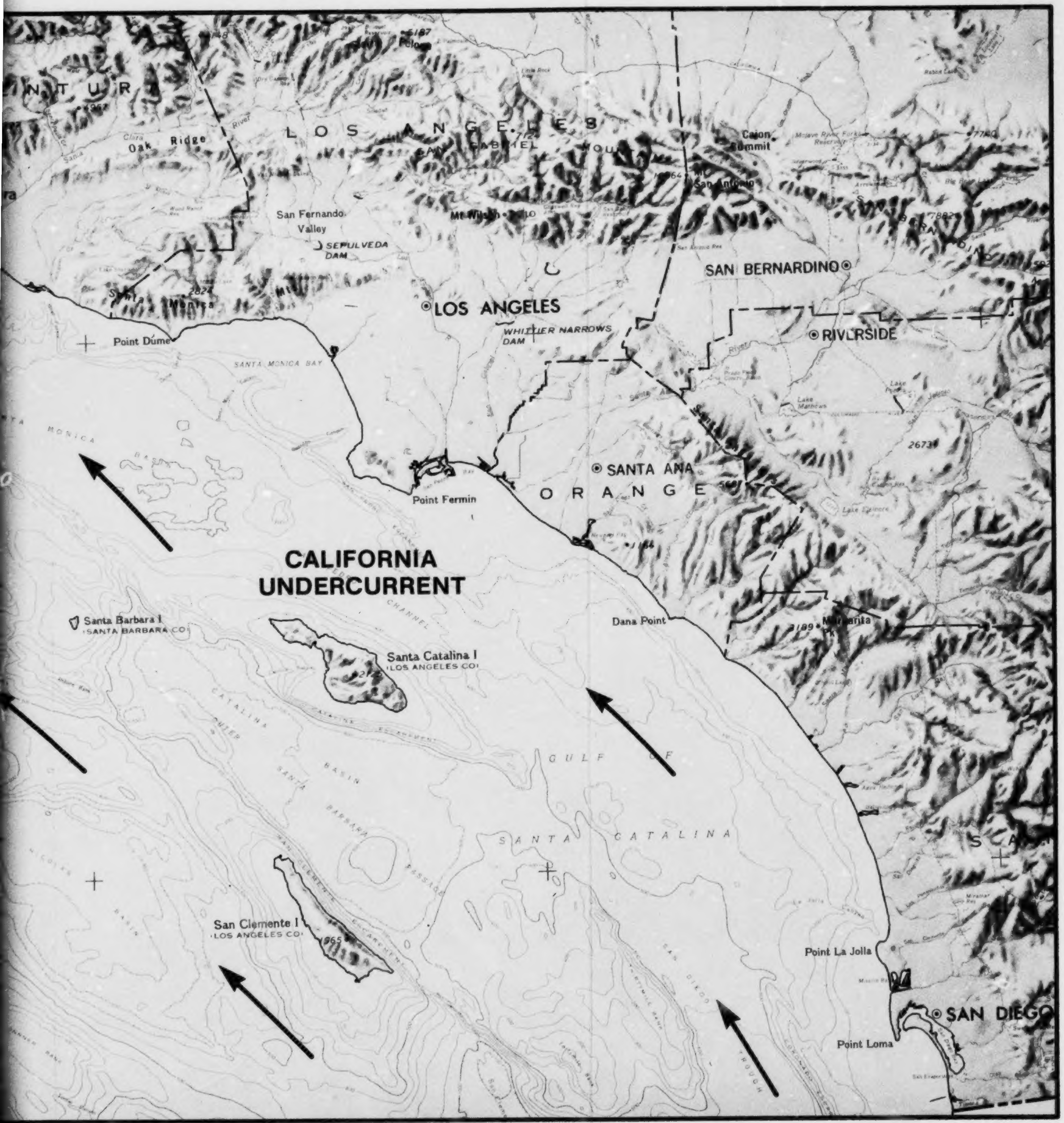
Figure III-A-4. Subsurface flow (mean geostrophic flow at 200 m in depth) in the Southern California Bight. The arrows show the approximate direction of flow. Depths are in fathoms (from Jones, 1971).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Oak Ridge
San Fernando Valley
SEPULVEDA DAM
Mt Wilson
Cajon Summit
Mt San Antonio
SAN BERNARDINO
LOS ANGELES
WHITTIER NARROWS DAM
RIVERSIDE
Lake Mathews
Lake Elsinore
SANTA ANA
ORANGE
Point Dume
SANTA MONICA BAY
Point Fermin
Dana Point
Santa Barbara I
SANTA BARBARA CO
Santa Catalina I
LOS ANGELES CO
San Clemente I
LOS ANGELES CO
GULF OF SANTA CATALINA
CATALINA BASIN
SANTA BARBARA PASSAGE
SAN DIEGO TROUGH
Point La Jolla
SAN DIEGO
Point Loma

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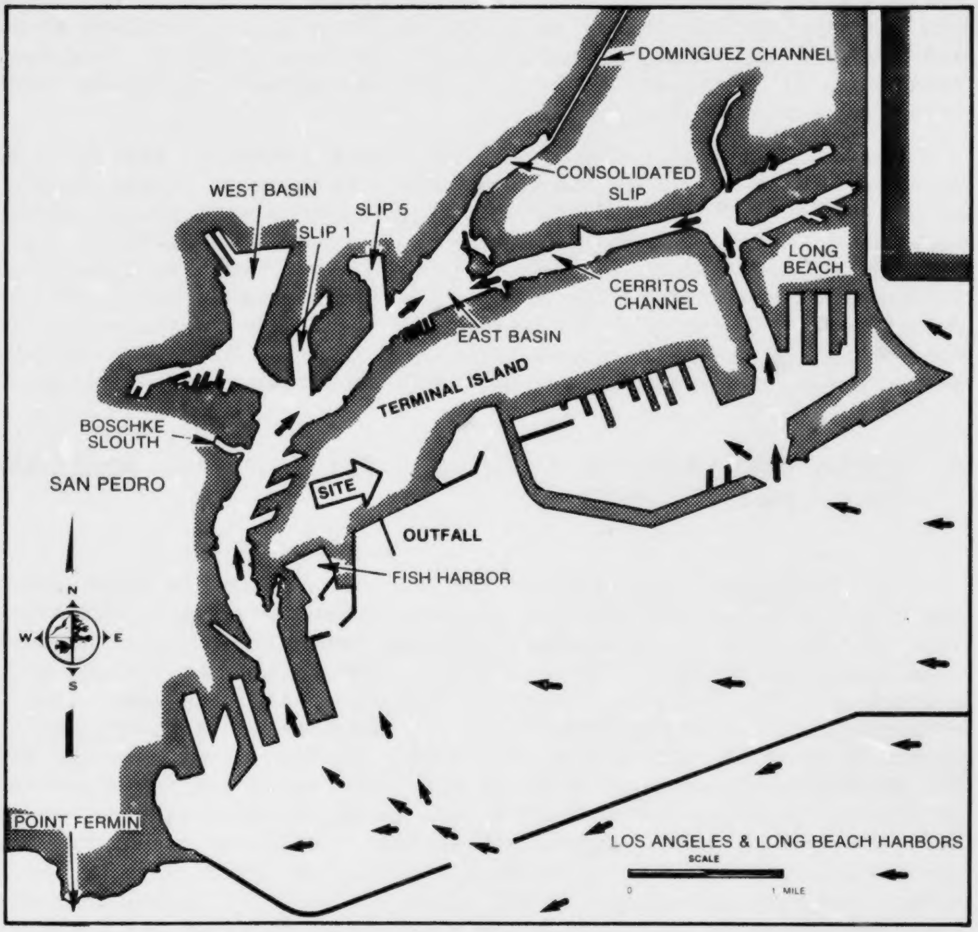
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WEST BASIN
SLIP 5
SLIP 1
LONG BEACH
CERRITOS CHANNEL
EAST BASIN
TERMINAL ISLAND
BOSCHKE SLOUTH
SAN PEDRO
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FISH HARBOR
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Figure III-A-5. Direction of currents during flood tide in Los Angeles-Long Beach Harbor. Maximum speeds of 0.8 to 1.0 knots were measured near the entrance of Los Angeles Harbor (Dames and Moore, 1973).

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in a process called upwelling. This process is important biologically because it brings to the surface nutrients which normally would not reach the euphotic (light penetration) zone (extending variably to 100 feet in Santa Monica Bay). Thus, the nutrients, particularly nitrogen, that are often present in concentrations that limit primary production (photosynthesis) are made available to phytoplankton and other organisms that can utilize them directly. As a result, there is an increased abundance and productivity of phytoplankton which, in turn, leads to increased abundances of all types of marine organisms—a chain of events generally regarded as beneficial.

Upwelling in the vicinity of deep sewage outfalls, such as those of Hyperion Treatment Plant, can be important because it brings constituents of the sewage effluent and sludge that would otherwise remain on the bottom or in deep water strata to the surface. A potential problem in the vicinity of deep marine sewage outfalls, however, is that along with the nutrients contributed by the sewage, there could be an upwelling of metals, chlorinated hydrocarbons, and other toxic substances which could enter the food chain, be concentrated, and damage the marine biota, or ultimately damage human, other mammalian, and avian consumers of marine life.

3. GENERAL CHARACTERISTICS OF THE WATER QUALITY OF SANTA MONICA BAY AND LOS ANGELES HARBOR

a. Salinity. The water of the Southern California Bight comes from two currents: the relatively low temperature-low salinity California Current from the north, and the relatively higher temperature-higher salinity California Undercurrent from the south. The California Current occurs at a depth of 40 to 600 meters with a salinity of 33.5 ppt (parts per thousand) characteristic of near-surface waters. The California Undercurrent occurs between 150-200 meters and 500-800 meters in depth in the Bight. Its maximum salinity reaches 34.35 ppt. The waters of the Southern California Countercurrent at 10 meters in depth have salinity values of 33.4 ppt to 34.6 ppt. Coastal variations in salinity result both from discharges from terrestrial sources (usually of lower salinity than sea water) and from upwelling of deep waters (usually of higher salinity than surface water, particularly where coastal dilution has occurred). Surface waters are more saline in summer than in winter because of evaporation in summer and rainfall in winter.

b. Dissolved Oxygen. The California State Water Resources Control Board (1965) requires, as a criterion for the propagation of fish, a dissolved oxygen level of not less than 5 mg/l. Dissolved oxygen at the surface is usually near saturation, and the concentration decreases with depth. The level of dissolved oxygen above 60 meters along the mainland shelf is consistently greater than 4 mg/l (SCCWRP, 1973). In deeper waters of the basins adjacent to the shelf, the dissolved oxygen levels are generally 0.3 to 0.4 mg/l below the sill depth (475 to 737 m) and may be as low as 0.1 mg/l (BLM, 1975). The water in the extreme bottom of the Santa Monica and Santa Barbara Basins (938 m and 627 m) is anoxic. Large amounts of decomposible organic material in the water and sediments of these basins are responsible for the low oxygen levels. In deeper waters outside of these basins, the dissolved oxygen concentrations reach 0.7 mg/l at a depth of 500 to 700 meters, increasing again to about 3 mg/l at a depth of 2,000 meters (BLM, 1975).

The mean dissolved oxygen concentration in the water at a depth of 90 m near the end of the HTP 7-mile outfall was 6.3 mg/l in October, 1972. This was only 1.6 mg/l lower than the value recorded at the surface. Concentrations measured near the bottom for three other stations around the outfall ranged from 6.5 to 7.0 mg/l (DPW, 1973).

c. Trace Metals. Concentrations of most trace metals, including cobalt, copper, iron, mercury, nickel, and zinc, in the Southern California Bight waters are similar to those found in other oceanic regions of the world (BLM, 1975). The concentration of lead in the Bight, however, is one to two orders of magnitude higher than concentrations in other regions (SCCWRP, 1973).

d. Hydrogen Ion Concentration (pH). The shelf water pH varies from about 7.5 to 8.6. High pH values may result from photosynthesis, which reduces CO_2 levels in the water. As photosynthesis decreases with depth, CO_2 increases as a result of respiration and decomposition, thus reducing the pH. The pH below the sill (737 m) of the Santa Monica Basin ranges from 7.68 to 7.77 (BLM, 1975).

e. Water Transparency. Along the coast of California, there is a variation in mean visual transparency from less than 6 meters to over 15 meters with the lowest visibility near the shore. Within one mile from shore, the visual transparency is commonly less than 6 meters opposite alluvial onshore areas and between 6 meters and 12 meters opposite rocky, nonalluvial regions (Allan Hancock Foundation, 1965).

f. Temperature. Water temperatures in the Southern California Bight vary seasonally in both vertical and horizontal distribution. The horizontal distribution of isotherms is influenced by currents with the Southern California Countercurrent or Davidson Current, bringing warmer waters north near shore. The mean temperatures at the surface and at 60 meters are given in Table III-A-1 for each quarter of the year. Temperatures at 150 meters remain fairly constant at 8.5 to 10 C with little seasonal or horizontal change (BLM, 1975).

Table III-A-1. Mean quarterly temperature in the nearshore waters of the Southern California Bight (Allan Hancock Foundation, 1965).

DATE	SURFACE TEMPERATURE (C)	60 M DEPTH TEMPERATURE (C)
January - March	14.5 - 16.0	10.5 - 14.0
April - June	15.0 - 17.0	10.0 - 11.5
July - September	16.0 - 21.5	10.0 - 13.5
October - December	16.0 - 20.0	12.5 - 15.0

During most of the year, the water column is characterized by variable density from top to bottom, mainly as a result of temperature stratification. The location in the water column where temperature and density change rapidly is termed the thermocline (or pycnocline), and this area represents a barrier for most vertical water movement except that caused by strong upwelling or vertical eddies. When the surface waters cool during late autumn to a temperature approaching that of the subthermocline water, free vertical exchange of water masses may occur. It is at this time that bouyant effluents (lower salinity, higher temperature) from deep ocean outfalls may disperse to surface waters.

Light transmission studies (a measure of suspended sediments) in Santa Monica Bay have not shown that the 5-mile effluent plume reaches the surface (Kolpack, 2 March 1977). On the other hand, coliform bacteria measurements have shown the plume to reach the surface in winter (see Section III.B.2).

Water quality data for the Los Angeles Harbor in 1970 are presented in Table III-A-2. The harbor waters are warmer and enriched with nutrients compared to the ocean outside the harbor.

4. GENERAL CHARACTERISTICS OF THE BOTTOM GEOLOGY AND SEDIMENTS IN SANTA MONICA BAY AND SAN PEDRO BAY

The Santa Monica Shelf extends from Point Dume to Palos Verdes Point and has been well-described (BLM, 1975). In this area rock and gravel occur close to shore in an elongated tract from Point Dume to Malibu, at the base of the Palos Verdes Hills, and in scattered locations across the central part of the shelf. Rocks in place in the latter area consist mostly of siliceous shales, with some mudstones and sandstones also present. A few of the mudstone samples analyzed contained Foraminifera of upper Miocene (Mohnian) age. Green glaucophane schist fragments were recovered and are believed to represent a submarine outcrop of San Onofre Breccia of upper Miocene age.

Table III-A-2. Summary of water quality data for Los Angeles Harbor in 1970 (Engineering-Science, Inc., 1971).

PARAMETER	AVERAGE LEVEL		
	INNER HARBOR	OUTER HARBOR	OCEAN
Transparency (m)	1.0	1.7	7.3
Temperature (C)	16.5	15.5	13.7
pH	7.54	7.76	7.95
DO (mg/l)	6.19	6.82	8.05
PO_4-P (mg/l)	0.18	0.19	0.15
Organic-N (mg/l)	0.7	0.4	0.3
Ammonia-N (mg/l)	3.0	0.5	0.1
Nitrate-N (mg/l)	0.13	0.08	0.09
Total Sulfide (mg/l)	0.20	0.46	0.17
COD (mg/l)	83	48	45
HEM (mg/l)	4.7	2.0	<0.2

The general sediment types present in the vicinity of Santa Monica Bay and San Pedro Bay are shown in Figure III-A-6. The chemical character of the sediments in the vicinity of the HTP outfalls is compared with that elsewhere in Santa Monica Bay in Section III.B.2.

Transported rocks are mainly well-rounded pebbles and cobbles of igneous rocks with some metamorphic and sedimentary types. The gravel is predominately associated with the rock outcrops, although varying amounts of small pebbles are found scattered throughout the sediments of the entire shelf. Phosphorite is abundant with the rock and gravel on the central shelf. It is usually in the form of nodules ranging in size from less than 2 mm to 100 mm. Phosphatized mammal bones and sharks teeth are also common. The unconsolidated sediments show a progressive decrease in grain size from sand near shore to silt at the outer edge of the shelf. This decrease is interrupted by the large area of rock and gravel north of Redondo Canyon and the coarse sand at the head of the Santa Monica Canyon.

These conditions are characteristic of many areas along California's coast in which shore-derived sediments move generally southward along the coastline until their course is interrupted by a submarine canyon such as the Redondo or Santa Monica Canyons. These canyons act as conduits for the transportation of these sediments seaward where they are eventually deposited in the deep ocean.

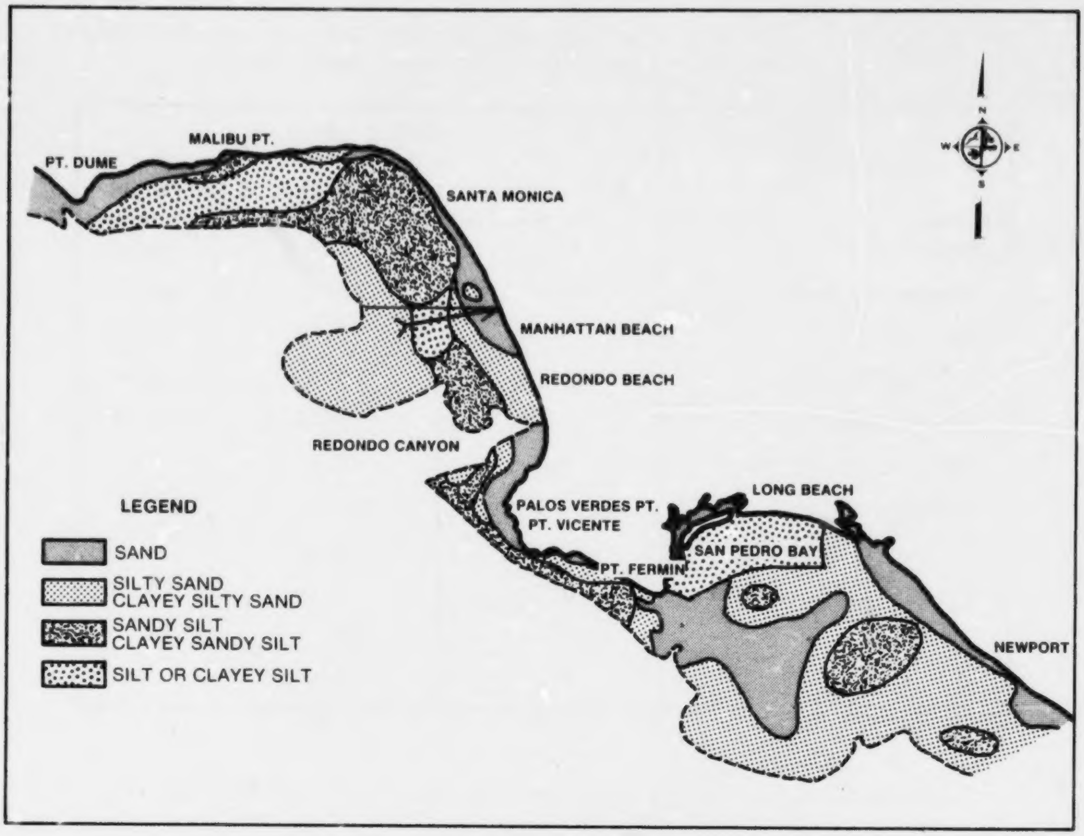
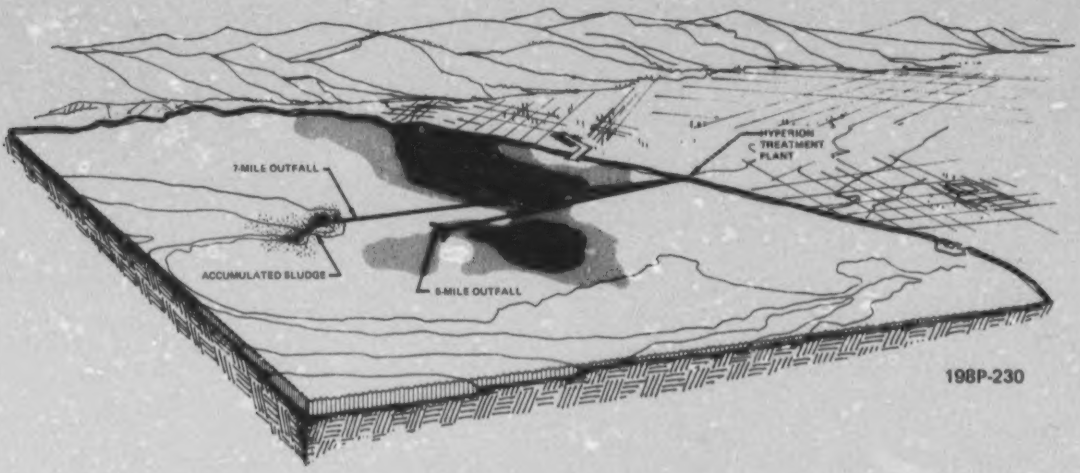

PT. DUME
MALIBU PT.
SANTA MONICA
MANHATTAN BEACH
REDONDO BEACH
REDONDO CANYON
PALOS VERDES PT.
PT. VICENTE
PT. FERMIN
LONG BEACH
SAN PEDRO BAY
NEWPORT
N
S
E
W
LEGEND
SAND
SILTY SAND
CLAYEY SILTY SAND
SANDY SILT
CLAYEY SANDY SILT
SILT OR CLAYEY SILT

Figure III-A-6. Sediment types of the mainland shelf area (from SWQCB, 1974). 198P-229

There are two areas of active oil seeps in the floor of Santa Monica Bay. One area, called the Redondo Seeps, is located near the head of Redondo Canyon, approximately two nautical miles from shore; the other, called the Manhattan Seeps, is about four nautical miles from the beach and northwest of the Redondo Seeps (see Figure III-A-1). The combined flow rate of these two seepage areas is on the order of 10 barrels (420 gallons) of oil per day (Marconsult, Inc., 1971). This amount of oil results in the formation of surface slicks extending several miles from each source on calm days. Numerous aerial and drift card surveys indicate that the prevailing drift of the Redondo seepage is towards the beach and north to Santa Monica. These same surveys indicate that only a small portion of the Manhattan seepage goes to shore; the rest presumably goes out to sea.

Numerous faults exist beneath the waters of Southern California. Two of the faults under Santa Monica Bay present a greater potential for earthquakes than the other Santa Monica Bay faults. These are the northern portion of the Palos Verdes fault which passes under the 5-mile and 7-mile outfalls about three miles west of the Hyperion Treatment Plant and the Redondo fault which underlies the trend of Redondo Canyon. While neither of these faults has been active during the last 200 years, they do show topographic expressions of movement during the last 2 million years which suggests that they are potentially active (California Division of Mines and Geology, 1973). The maximum probable earthquake on the Palos Verdes fault during the next 100 years is a magnitude 5. This potential for movement raises the possibility of earthquake-induced ruptures of the overlying 5-mile and 7-mile Hyperion Treatment Plant outfalls.


7-MILE OUTFALL
HYPERION TREATMENT PLANT
ACCUMULATED SLUDGE
5-MILE OUTFALL
19BP-230

B. chemical and physical inputs

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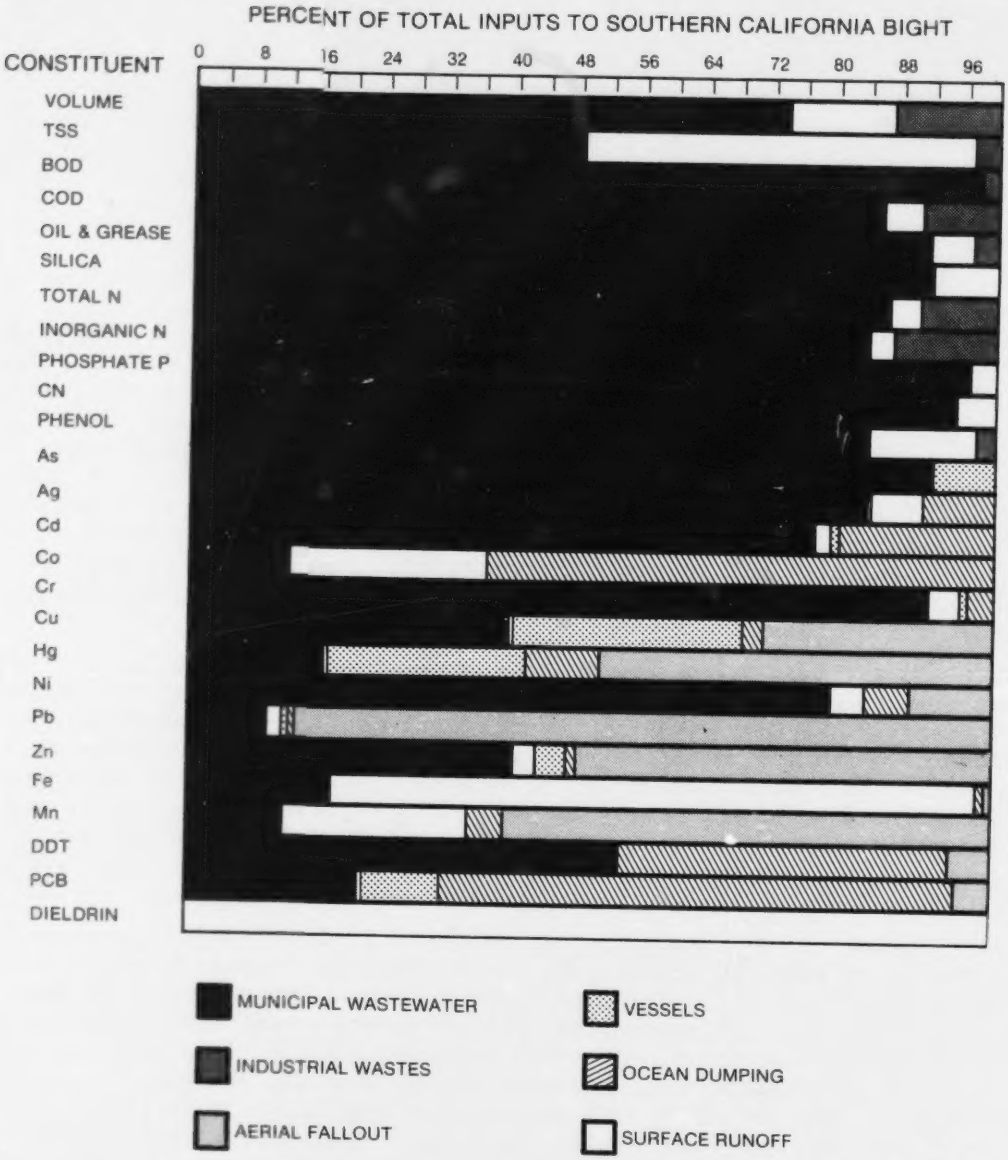
B. CHEMICAL AND PHYSICAL INPUTS

1. INTRODUCTION

Wastewater and sludge discharges contribute significant percentages of most of the nutrients, toxicants, and other pollutants entering the Bight, but they are, by no means, the only sources. Other point sources of pollutants include surface runoff entering the ocean from rivers, storm drains, and creeks, and discharges from large industrial operations, such as oil refineries. Major sources which contribute a more diffuse (nonpoint source) input include atmospheric fallout (both dry fallout and rain washout falling directly into the ocean), surface coatings, fuels, and zinc anodes used on ocean vessels (actually point sources, but distributed diffusely throughout the Bight), and ocean dumping and combustion of waste products.

In addition, there are detectable levels of many pollutants in water entering the Bight via the California Current. These are the background concentrations that organisms in the Bight would be exposed to in the absence of inputs resulting from human activities in and adjacent to the Bight. The constituents imported by advective transport are also exported as the current passes out of the Bight, and the net retention of these consituents in the Bight is unknown. The effects on the marine ecosystem of the substances brought into the Bight by advection relative to the effects of inputs resulting from human activities are unknown.

Figure III-B-1 and Table III-B-1 show the 1971 annual mass emission rates of various pollutants into the Southern California Bight from point and nonpoint sources. These data are presented because they are the most recent that include inputs from all sources, and are intended to give a comparative overview of historic relative contributions from various sources. The absolute and relative inputs from all sources have changed with time, and not all have been measured regularly. More recent data have been used (when available) for impact assessment in this report. The 1971 data show that municipal wastewater discharges contributed more than 85 percent of the nutrients, an average of 45 percent of the metals, 54 percent of the DDT, and 22 percent of the PCB's to the Southern California Bight. Nutrients that have been contributed to the bottom sediments and to deep waters by natural biological processes, and that are transferred to the euphotic zone by upwelling, are not included in Table III-B-1.



198P-231

Figure III-B-1. Average annual mass emission rates for pollutants from each of the major point and nonpoint sources to the Southern California Bight in 1971 (data from SCCWRP, 1973).

Table III-B-1. 1971* average annual mass emission rates for pollutants from each of the major point and nonpoint sources to the Southern California Bight (SCCWRP, 1973).

CONSTITUENT	POINT SOURCES						NON-POINT SOURCES						TOTAL T/YR
	MUNICIPAL WASTEWATER		SURFACE RUNOFF		INDUSTRIAL WASTES		VESSELS		OCEAN DUMPING		AERIAL FALLOUT		
	T/YR	% OF TOTAL	T/YR	% OF TOTAL	T/YR	% OF TOTAL	T/YR	% OF TOTAL	T/YR	% OF TOTAL	T/YR	% OF TOTAL	
Volume[1]	1,380	74	242	13	251	13							1,873
TSS	278,000	49	274,000[2]	48	16,000	3							568,000
BOD	291,000	98	---	--	6,000	2							297,000
COD	675,000	86	29,000	4	78,000	10							782,000
Oil and Grease	65,000	91	4,400	6	2,200	3							71,600
Silica	33,000	92	2,800	8	---	--							35,800
Total Nitrogen	84,792	88	2,506	3	9,500	10							96,798
Inorganic Nitrogen[3]	59,929	85	1,419	2	9,500	13							70,848
Phosphate P	13,263	97	410	3	---	--							13,673
CN	210	95	11	5	---	--							221
Phenols	1,728	85	269	13	43	2							2,040
As[4]	20.9	93					1.5	7					22.4
Ag	15	85	1.1	6					1.5	9			17.6
Cd	54	78	1.2	2			0.1	0.1	14	20			69.3
Co	3.0	14	5.3	24			--	--	14	63			22.3
Cr	649	92	25	4			1	0.1	28	4			703
Cu	567	41	18	1			386	28	28	2	400	29	1,399
Hg	2.9	18	0.06	0.4			4	24	1.5	9	8	49	16.46
Ni	313	79	17	4			--	--	28	7	40	10	398
Pb	211	6	90	2			10	0.3	28	0.8	3,400[5]	91	3,739
Zn	1,680	40	101	2			164	4	56	1	2,200	52	4,201
Fe	6,000	19	26,000	81			--	--	280	0.9	40	0.1	32,320
Mn	102	13	183	23			--	--	28	4	480	61	793
Total DDT	19.2	54	0.119	0.3			--	--	14	40	2[6]	6	35.32
Total PCB	9.7	22	0.246	0.6			4	9	28	64	2[6]	5	43.95
Dieldrin	---	--	0.031	100			-	-	-	-	-	-	0.03

[1] Volume is 10^6 m^3/year.

[2] Silt.

[3] Ammonia + nitrate nitrogen.

[4] Municipal wastewater value from 1974 data (SCCWRP, 1975a).

[5] Includes 2,400 metric tons/year dry fallout (Chow and Earl, 1970).

[6] Estimated dry fallout.

NOTE: This table shows that municipal wastewater discharges contribute almost all of the nutrients, about half of the metals and DDT, and about a fifth of the PCB's entering the Bight from identifiable land-based sources. However, nutrients, in particular, are also contributed by upwelling of water from below the euphotic zone and by recycling within marine food chains. The relative contribution of nutrients derived from wastewater discharges compared to those arriving in the euphotic zone from natural oceanic physical and biological processes is not known. In Chapter 7 of this report it is shown that only a very small percentage of nutrients removed from the Bight in the commercial fish catch can be attributed to wastewater discharges.

Blanks in the table do not necessarily mean no input but may indicate that the constituent was not tested for.

*1971 was the most recent year for which data from all of these sources was available.

Chlorinated benzenes are environmental contaminants that have received little attention until recently, and, thus, are not included in Figure III-B-1 or Table III-B-1. These chemicals, particularly ortho- and para-dichlorobenzene, have both industrial and residential uses (SCCWRP, 1976). Para-DCB is used in products that vaporize, such as moth repellants, mildew retardants, and space deodorizers, while o-DCB is used for such things as engine cleaning solvents, lacquer and resin solvents, and rust proofing. Trichlorobenzenes (TCB) are used in oil dye and grease solvents, termite exterminators, and lubricating oil additives.

Chlorinated benzenes enter the Bight mainly through wastewater discharges (SCCWRP, 1976). Para-DCB, o-DCB, and 1, 2, 3-TCB occur in wastewater effluents in concentrations approximately equal to PCBs while hexachlorobenzene (HCB) and 1, 3, 5-TCB are at considerably lower concentrations.

The HTP influent wastewater is made up of 88 percent domestic sewage and 12 percent industrial wastes during dry weather. During wet weather, infiltration of surface water and groundwater into the sanitary sewer system can contribute up to 15 percent of the total flow (DPW, 1973). The average concentrations of selected constituents in the final effluent for 1974 are included in Table III-B-2.

2. MUNICIPAL WASTEWATER AND SLUDGE DISCHARGES

The 25 municipal outfalls discharging into the Southern California Bight are mapped in Figure III-B-2, and the percentage by volume of effluent contributed by the major outfalls is also shown. The Hyperion Treatment Plant contributes 34 percent of the wastewater (including sludge) volume, while the Terminal Island Treatment Plant contributes less than 1 percent.

The concentration and mass emission rates for a representative year (1974) of various wastewater consituents contributed by the major wastewater discharges are shown in Tables III-B-2 and III-B-3. Table III-B-4 illustrates that although HTP contributed 34 percent of the total volume discharges to the Bight in 1974, it contributed a smaller percentage of the total mass emissions for at least 14 of 21 constituents.

a. Hyperion Treatment Plant.

The Hyperion Treatment Plant (HTP) has been discharging wastewater into Santa Monica Bay since 1894 (SWQCB, 1964). The initial volume was 107 mgd (million gallons per day), and the discharge remained constant until 1934. The effluent volume has generally increased since that time to 362 mgd in 1976 (Figure III-B-3). The ocean discharge point has changed over the years as new and longer pipes were installed, progressing from a 183-meter (600-foot) long pipe

Table III-B-2. Average concentrations of general constituents, trace metals, and chlorinated hydrocarbons, in the final effluent of municipal waste dischargers for 1974 (SCCWRP, 1975a; DPW, 1975a).

CONSTITUENT	JWPCP (LA COUNTY)	HYPERION (LA CITY)		ORANGE[1] COUNTY (SAN DIEGO)	POINT LOMA	OXNARD	TERMINAL ISLAND (LA CITY)
		5-MILE	7-MILE				
Flow (mgd)	346	341	4.72	171	104	10.1	10.3
General Constituents (mg/l)							
Total Suspended Solids	276	83	7,300	107	138	168	151
Volatile Suspended Solids	182	66	4,700	75	106	---	---
5-day BOD	213	121	1,900[2]	150	190	251	159
Chemical Oxygen Demand	613	250	7,700[2]	---	---	---	342
Oil and Grease	55.1	18	900	34.8	41.1	39.2	22
Nitrate Nitrogen	0.15	0.3	---	---	---		0.3
Ammonia Nitrogen	38.5	13.8	300[2]	34.8	26.5	---	20.9
Organic Nitrogen	15.7	6.3	250[2]	---	---	---	9.4
Total Nitrogen	54.4	20.4	550[2]	---	38.0	---	30.6
Total Phosphate	47.5	24.3	663[2]	---	---	---	34.0
Detergent (MBAS)	6.85	5.1	---	---	7.96	1.25	9.2
Cyanide	0.43	0.2	0.53	---	0	0.005	0.11
Phenols	3.31	0.06	---	---	0.23	0.16	0.07
Trace Metals (mg/l)[3]							
Silver	0.012	0.02	0.40	0.012	0.008	0.008	0.02
Arsenic	0.025	0.01	0.18	---	<0.026	0.001	0.01
Cadmium	0.041	0.02	1.27	0.061	0.026	0.012	0.01
Chromium	0.86	0.21	15.1	0.28	0.11	0.020	0.20
Copper	0.60	0.19	13.9	0.40	0.10	0.074	---
Iron	8.17	0.64	78.7	---	6.40	1.00	0.88
Mercury	0.0011	0.0032	0.15	---	0.0005	---	0.0044
Manganese	0.11	0.02	0.19	---	0.40	0.10	0.03
Nickel	0.31	0.18	3.1	0.23	0.049	---	0.27
Lead	0.26	0.04	1.13	0.17	0.059	0.13	0.07
Selenium	0.012	0.02	0.40	---	---	0.014	0.19
Zinc	1,79	0.24	23.9	0.54	0.50	0.28	0.36
Chlorinated Hydrocarbons (μg/l)							
Total DDT	3.01	0.12[4]	2.59	---	2.32	<0.25	
Total PCB	10.8[5]	0.35[6]	122[6]	17.1	---	---	0.0013[7]
Dieldrin	0.01	0.01	0.17	---	---	<0.10	

[1] All Orange County values based on 10 months of data (no May-June data) except flow, cyanide, and total PCB, which are based on 6 months of data (July-December).

[2] Based upon analysis of 10 weekly composites.

[3] Point Loma trace metals based on less than 12 months: silver, 9 months; copper, 4 months; iron, 2 months; manganese, 5 months.

[4] Calculated from mass emission rate of Table III-B-3 (SCCWRP data). The HTP value was 0.72 μg/l.

[5] The average concentration for January to September was 4.72; for October to December, 29.1.

[6] These values were determined independently by SCCWRP (Young et al., 1975, page 5) and are similar to the HTP values for the 5-mile effluent but substantially higher (122 ug/l compared with 3.3 ug/l) for the 7-mile effluent.

[7] Total identifiable chlorinated hydrocarbons.

Table III-B-3. Mass emission rates of general constituents, trace metals, and chlorinated hydrocarbons in the final effluent of municipal waste dischargers for 1974 (SCCWRP, 1975a; DPW, 1975a).

CONSTITUENT	JWPCP	HYPERION		ORANGE COUNTY	POINT LOMA	OXNARD	TERMINAL ISLAND
		5-MILE	7-MILE				
Flow (mgd)	346	341	4.72	171	104	10.1	10.3
General Constituents (metric tons/yr)							
Total Suspended Solids	132,000	39,100	47,500	25,200	19,800	2,340	2,148
Volatile Suspended Solids	86,900	31,100	30,600	17,700	15,200	---	---
5-day BOD	102,000	56,900	12,400	35,400	27,300	3,500	2,263
Chemical Oxygen Demand	293,000	118,000	50,200	---	---	---	4,867
Oil and Grease	26,300	8,470	5,860	8,210	5,900	546	313
Nitrate Nitrogen	71.6	141	---	---	---	---	4.3
Ammonia Nitrogen	18,400	6,490	1,950	8,210	3,800	---	297
Organic Nitrogen	7,500	2,960	1,628	---	---	---	134
Total Nitrogen	26,000	9,600	3,580	9,300	5,450	---	436
Total Phosphate	22,700	11,400	4,320	---	---	---	484
Detergent (MBAS)	3,270	2,400	---	---	1,140	17.4	131
Cyanide	205	94.1	3.45	---	---	0.07	1.6
Phenols	1,580	28.2	---	---	33.0	2.23	1.0
Trace Metals (metric tons/yr)							
Silver	5.73	9.41	2.61	2.83	1.15	0.11	0.29
Arsenic	11.3	4.71	1.17	---	<3.73	0.014	0.14
Cadmium	19.6	9.41	8.27	14.4	3.73	0.17	0.14
Chromium	411	98.8	98.4	66.1	15.8	0.28	2.85
Copper	286	89.4	90.5	94.4	14.4	1.03	---
Iron	3,900	301	513	---	919	13.9	12.5
Mercury	0.53	1.51	0.98	---	0.07	---	0.06
Manganese	52.5	9.41	1.24	---	57.4	1.39	0.43
Nickel	148	84.7	20.2	54.3	7.03	---	3.84
Lead	124	18.8	7.36	40.1	8.47	1.81	1.0
Selenium	5.73	9.41	2.61	---	---	0.20	2.7
Zinc	855	113	156	127	71.8	3.90	5.1
Chlorinated Hydrocarbons (kg/yr)							
Total DDT	1,440	56[3]	17[3]	---	333	<3.48	
Total PCB	5,160[1]	160[3]	790[3]	4,040	---	---	0.019[2]
Dieldrin	4.77	4.71	1.11	---	---	<1.39	

[1] Two-thirds of this amount (3,470 kg) was discharged during the 3-month period, October to December.

[2] Total identifiable chlorinated hydrocarbons.

[3] These data are from an independent analysis of DDT and PCB in the Hyperion Effluent by SCCWRP (1975a, page 106). The mass emission rates of DDT calculated by HTP at the 5-mile outfall are 6 times those calculated by Young, et al., but are identical at the 7-mile outfall. The total PCB emission rates calculated by Young, et al. are similar to the HTP calculations at the 5-mile outfall, but are 37 times those calculated by HTP at the 7-mile outfall.

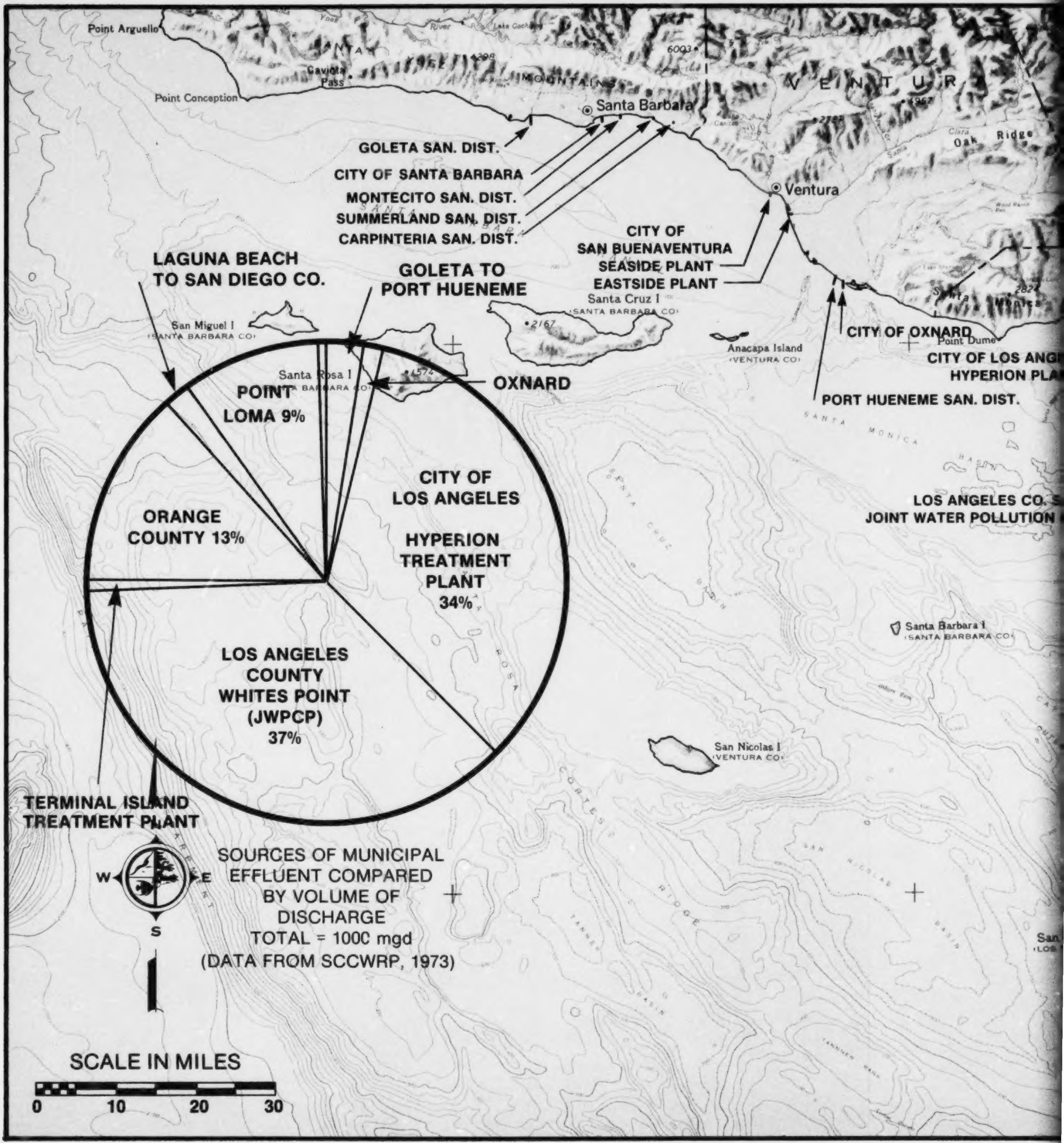
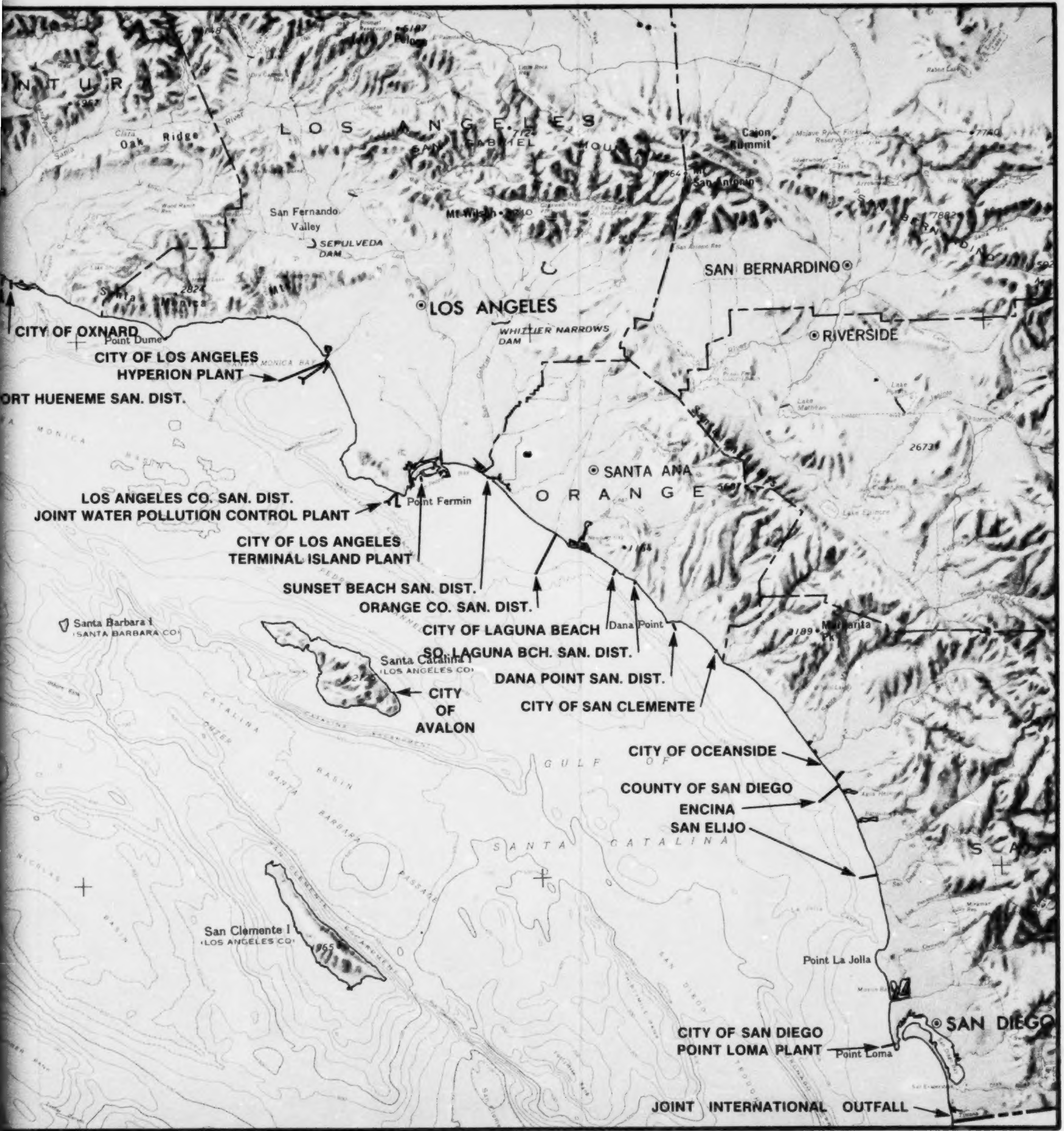

Point Arguello
Point Conception
Gaviota Pass
Santa Barbara
Ventura
Oak Ridge
GOLETA SAN. DIST.
CITY OF SANTA BARBARA
MONTECITO SAN. DIST.
SUMMERLAND SAN. DIST.
CARPINTERIA SAN. DIST.
CITY OF SAN BUENAVENTURA
SEASIDE PLANT
EASTSIDE PLANT
LAGUNA BEACH TO SAN DIEGO CO.
GOLETA TO PORT HUENEME
San Miguel I (SANTA BARBARA CO)
Santa Cruz I (SANTA BARBARA CO)
Santa Rosa I (SANTA BARBARA CO)
Anacapa Island (VENTURA CO)
CITY OF OXNARD
Point Dume
CITY OF LOS ANG
HYPERION PLA
PORT HUENEME SAN. DIST.
OXNARD
POINT LOMA 9%
CITY OF LOS ANGELES HYPERION TREATMENT PLANT 34%
ORANGE COUNTY 13%
LOS ANGELES COUNTY WHITES POINT (JWPCP) 37%
LOS ANGELES CO. S
JOINT WATER POLLUTION
Santa Barbara I (SANTA BARBARA CO)
San Nicolas I (VENTURA CO)
TERMINAL ISLAND TREATMENT PLANT
W
E
S
SOURCES OF MUNICIPAL EFFLUENT COMPARED BY VOLUME OF DISCHARGE
TOTAL = 1000 mgd
(DATA FROM SCCWRP, 1973)
SCALE IN MILES
0
10
20
30

Figure III-B-2. The 25 municipal wastewater outfalls discharging to the Southern California Bight. The length of the outfall pipes are shown to scale. Depths are in fathoms (data from SCCWRP, 1973).


LOS ANGELES
SAN GABRIEL MOUNTAINS
Oak Ridge
San Fernando Valley
SEPULVEDA DAM
Mt Wilson
Cajon Summit
San Antonio
SAN BERNARDINO
LOS ANGELES
WHITTIER NARROWS DAM
RIVERSIDE
SANTA ANA
ORANGE
CITY OF OXNARD
Point Dume
CITY OF LOS ANGELES HYPERION PLANT
ORT HUENEME SAN. DIST.
LOS ANGELES CO. SAN. DIST. JOINT WATER POLLUTION CONTROL PLANT
Point Fermin
CITY OF LOS ANGELES TERMINAL ISLAND PLANT
SUNSET BEACH SAN. DIST.
ORANGE CO. SAN. DIST.
CITY OF LAGUNA BEACH
Dana Point
SO. LAGUNA BCH. SAN. DIST.
DANA POINT SAN. DIST.
CITY OF SAN CLEMENTE
Santa Barbara I (SANTA BARBARA CO)
Santa Catalina I (LOS ANGELES CO)
CITY OF AVALON
GULF OF SANTA CATALINA
CITY OF OCEANSIDE
COUNTY OF SAN DIEGO
ENCINA
SAN ELIJO
San Clemente I (LOS ANGELES CO)
Point La Jolla
SAN DIEGO
CITY OF SAN DIEGO POINT LOMA PLANT
Point Loma
JOINT INTERNATIONAL OUTFALL

198P-231

1 P.

Table III-B-4. Percentage of total volume and mass emission of selected wastewater constituents contributed by Hyperion to the Southern California Bight in 1974 (calculated from SCCWRP, 1975a).

SELECTED CONSTITUENT	PERCENT OF TOTAL CONTRIBUTED BY HTP[1]
Volume	34
Ammonia N[2]	22
Nitrate N[3]	66
Phosphate[4]	41
BOD	29
COD[4]	37
Cyanide[5]	32
Silver	55
Arsenic[6]	28
Cadmium	32
Chromium	29
Copper	31
Iron[6]	14
Mercury[7]	81
Manganese[6]	9
Nickel[3]	31
Lead	13
Selenium[5]	67
Zinc	20
DDT	5
PCB	17
Dieldrin[5]	49

[1] The major dischargers are JWPCP, HTP, Orange County, Point Loma and Oxnard, and data were not available for all constituents from each source. Sludge and effluent are combined.

[2] Excluding Oxnard (1% of total volume discharged).

[3] JWPCP and HTP 5-mile effluent only (70% of total volume discharged).

[4] JWPCP and HTP only (71% of total volume discharged).

[5] Excluding Orange County and Point Loma (28% of total volume discharged).

[6] Excluding Orange County (18% of total volume discharged).

[7] Excluding Orange County and Oxnard (19% of total volume discharged).

NOTE: This table shows that the mass emission of various wastewater constituents by Hyperion is not proportional to the volume discharged in comparison to other wastewater dischargers to the Bight.

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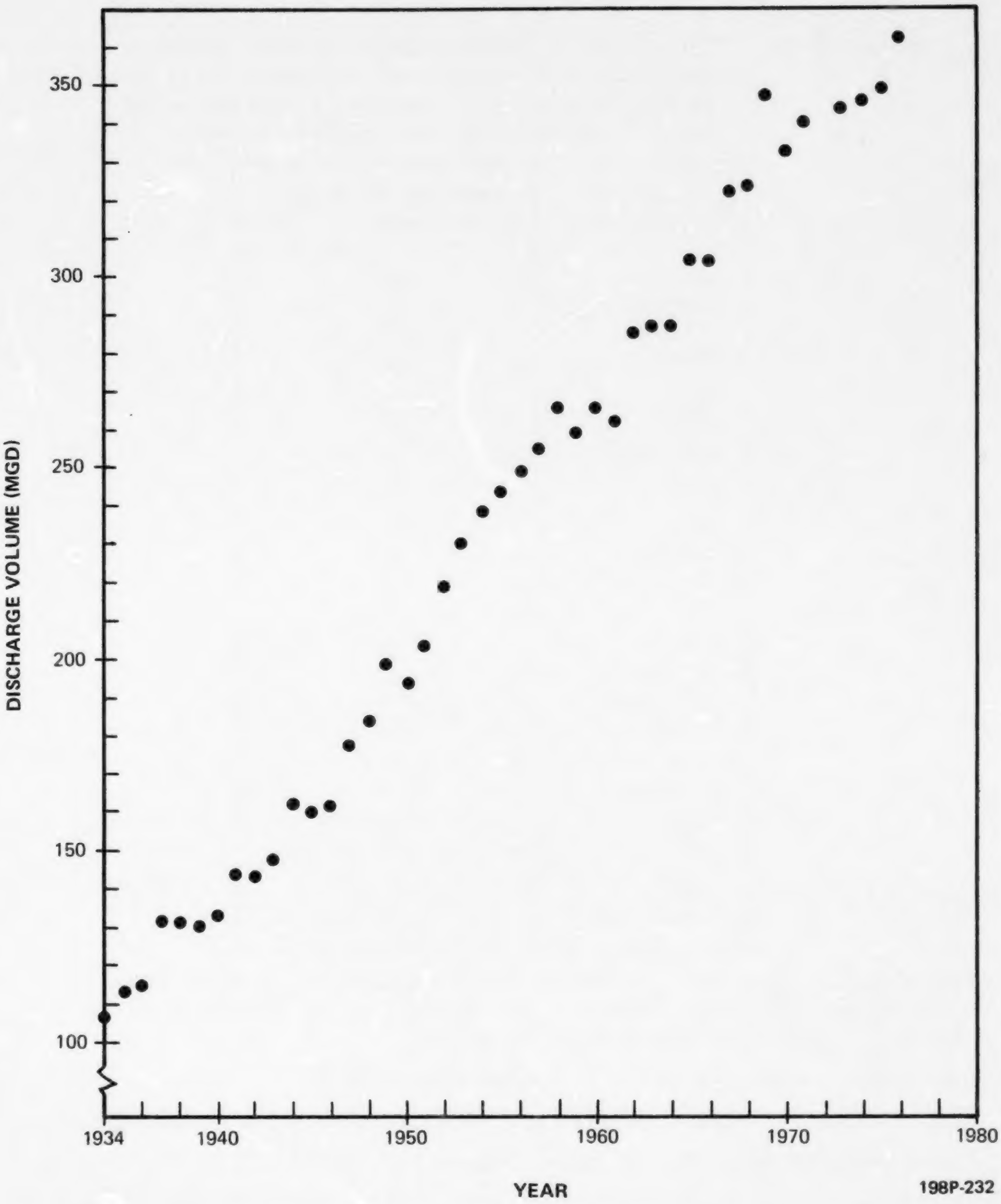


Figure III-B-3. Hyperion Treatment Plant mean daily effluent volumes from 1934 through 1976 (SWQCB, 1964; SCCWRP, 1973; SCCWRP, 1974; SCCWRP, 1975a; SCCWRP, 1976; Cross, 4 March 1977).

in 1894 to the present 5-mile effluent and 7-mile sludge pipes. The pipe length, diameter, and date of completion as well as type of effluent treatment are summarized in Table III-B-5. It is of interest to note that primary treatment was not initiated until 1949, meaning that raw sewage was discharged less than 1 mile offshore prior to that time.

The present ocean outfalls (see Figures III-B-4 and III-B-5) include a 1-mile outfall no longer used but kept ready for overflow use if necessary, a 5-mile outfall for treated wastewater with two 1,219-meter (4,000-foot) diffuser arms with multiple ports at an average depth of 57 meters (188 feet), and an outfall used for discharging sludge mixed with secondary effluent located 7 miles offshore at the head of Santa Monica Canyon in 98 meters (320 feet) of water. These are known as the 1-mile, 5-mile, and 7-mile outfalls. The average volume of effluent in 1974 was 341 mgd with 100 mgd of this receiving secondary treatment (SCCWRP, 1975a). The flow, however, can vary from 160 to 460 mgd within a 24-hour period and, typically, has one high and low flow each day (DPW, 1975b). Sludge and secondary effluent mixed together are currently discharged through the 7-mile outfall at an average rate of 4.72 mgd.

Table III-B-5. Hyperion Treatment Plant ocean outfall characteristics and treatment type from 1894 to 1975 (from SWQCB, 1964, and DPW, 1976).

YEAR	OUTFALL LENGTH (km)	DIAMETER (m)	TREATMENT
1894	0.18	0.61	None
1904	0.29	0.76	
1908	0.29	0.86	
1918	0.61	1.37	
1925	1.52	2.13	Fine screening
1949	1.61	3.66	
1950			Primary
1951			Secondary (1/3 of effluent only)
1952			High rate activated sludge
1957	11.27	0.61	
1960	8.05	3.66	

Note: The 11.27 km (7-mile) outfall is for discharge of the solids (except those converted to gas and water) removed in the treatment process. All outfalls prior to the 1.61 km (1-mile) outfall are no longer in use, and the 1.61 km outfall is only used for overflows now.

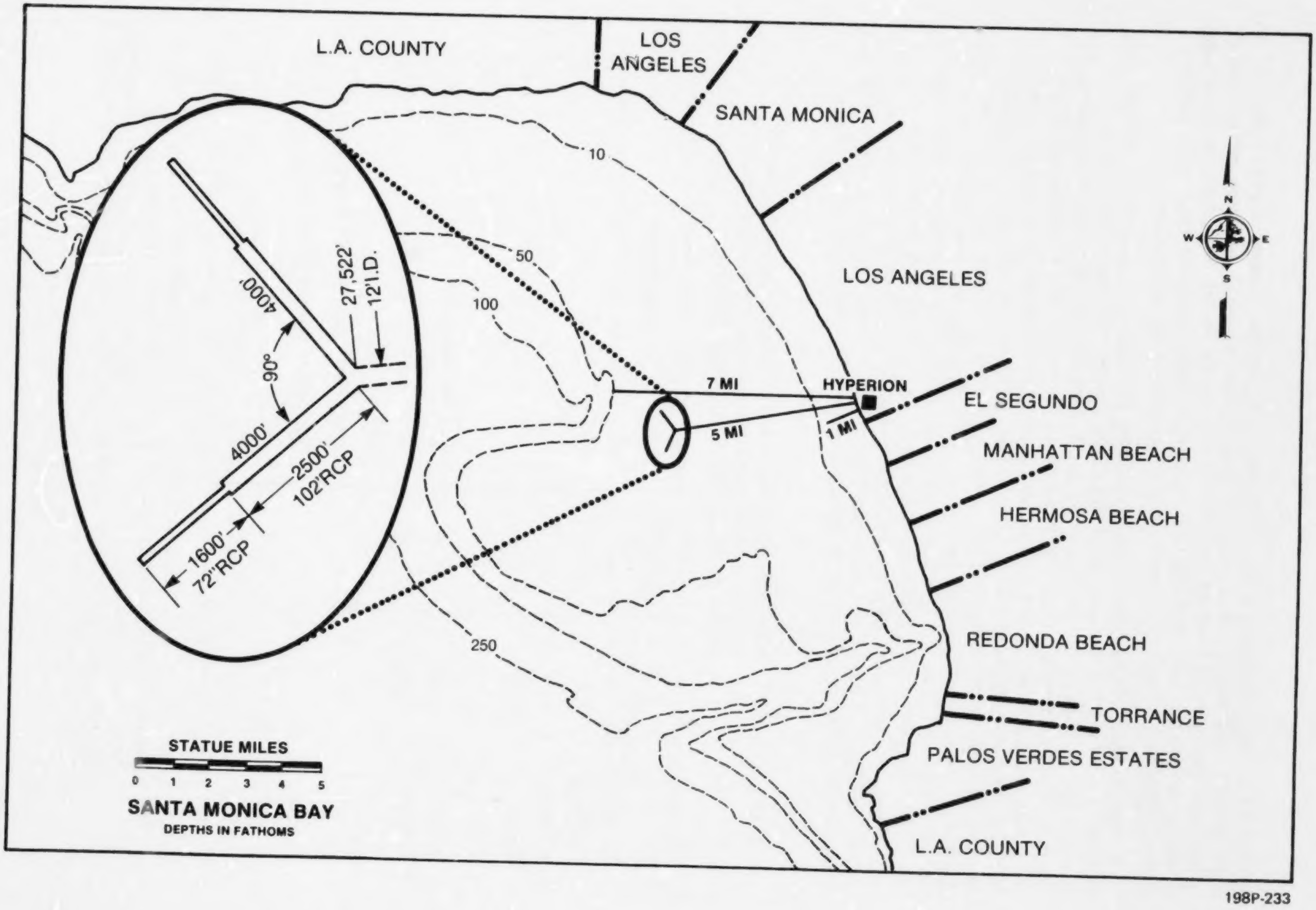
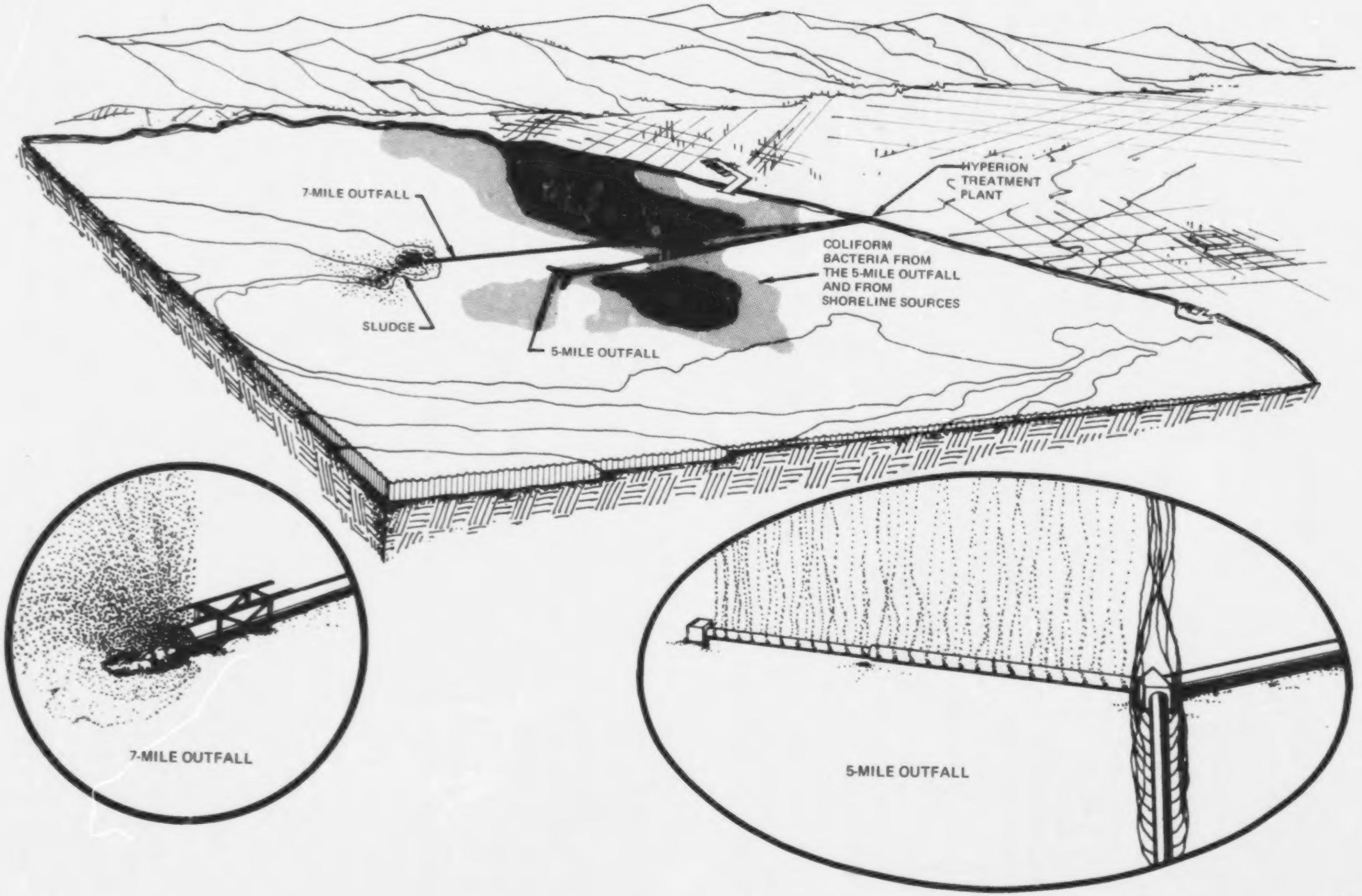

L.A. COUNTY
LOS ANGELES
SANTA MONICA
LOS ANGELES
HYPERION
7 MI
5 MI
1 MI
EL SEGUNDO
MANHATTAN BEACH
HERMOSA BEACH
REDONDA BEACH
TORRANCE
PALOS VERDES ESTATES
L.A. COUNTY
10
50
100
250
N
W
E
S
27,522'
12'I.D.
4000'
90°
4000'
2500'
102"RCP
1600'
72"RCP
STATUE MILES
0
1
2
3
4
5
SANTA MONICA BAY
DEPTHS IN FATHOMS
198P-233

Figure III-B-4. The Hyperion Treatment Plant outfalls. RCP is reinforced concrete pipe (adapted from DPW, 1976).


HYPERION TREATMENT PLANT
7-MILE OUTFALL
COLIFORM BACTERIA FROM THE 5-MILE OUTFALL AND FROM SHORELINE SOURCES
SLUDGE
5-MILE OUTFALL
7-MILE OUTFALL
5-MILE OUTFALL

198P-32

Figure III-B-5. Hyperion Treatment Plant outfalls with an artist's representation of the sludge (not to scale) and wastewater discharges. The January 1974 surface coliform bacteria (from the HTP effluent and shoreline sources) are also shown.

(1) EMISSION OF METALS FROM HTP. The mass emission rates of selected metals (and cyanide) through the HTP 5- and 7-mile outfalls for 1971, 1973, 1974, and 1975 are listed in Tables III-B-6 and III-B-7. These tables show that over the past 5 years, no single trend is obvious for all constituents. There has been a general trend of decreasing mass emission rates for chromium, manganese, nickel, and zinc in both discharges. Iron and lead, on the other hand, showed opposite trends between the two outfalls with decreases in the 5-mile effluent and increases in the 7-mile effluent. For the other metals shown, there is no certain change between 1971 and 1975. The 1971 value for silver appears to be unrealistically low, and a split sample analysis conducted by Galloway (cited by SCCWRP, 1973) suggests that in 1971 the analytical procedures being used at HTP underestimated silver concentrations by an order of magnitude. Silver analyses were first required at HTP in 1971, and the HTP Treatment Division was constrained to utilize wet chemical analytical methods specified by the Water Quality Control Board until such time as it had information which showed another technique was more accurate. The Division used the required method until it obtained atomic absorption instrumentation and confirmed its use with the Control Authorities. By 1973 it had made the necessary changes so the apparent order of magnitude error should not be applicable to values obtained in 1973 through 1975 (Nagano, 18 November 1976).

(2) EMISSION OF CHLORINATED HYDROCARBONS FROM HTP. The concentrations (measured by HTP) of the compounds making up the total identifiable chlorinated hydrocarbons (TICH) are shown in Table III-B-8 for the 5-mile and 7-mile effluents in 1975. A comparison of the 1975 values for dieldrin, DDT, and PCB with the data for 1974 in Table III-B-2 shows that the discharge of dieldrin has increased about one order of magnitude for both effluents. Total DDT (DDT + DDE + DDD) concentrations increased by more than an order of magnitude (0.12 vs. 1.63 μg/l) in the 5-mile effluent but only by a factor of 2 (2.59 vs. 6.33 μg/l) in the 7-mile effluent. The concentration of Aroclor 1242 (1242 PCB), the only PCB measured in 1975, was more than an order of magnitude greater than the total PCB concentration reported in 1974 for the 5-mile effluent, while in the 7-mile effluent, the concentration of Aroclor 1242 in 1975 was only one-seventh of the total PCB concentration reported in 1974. The HTP data in the footnotes to Table III-B-2 were not used for these comparisons since split sample analysis of HTP effluent by three laboratories (SCCWRP, Bodega Marine, and HTP) in 1974 showed that the concentrations measured by HTP were more than two orders of magnitude lower than those of the others (Young et al., 1975). Hyperion Treatment Plant personnel now feel that their analytical accuracy is comparable to that at other sources, viz.: "Early HTP analyses were done by contract with outside laboratories, and it was necessary to obtain complex new gas-chromatographic equipment and develop special extracting, sample clean-up, and analytical techniques before satisfactory in-house analyses were possible. Present data from all laboratories are an estimate at best, since only a portion of the chromatographic curve obtained is

Table III-B-6. Annual mass emission rates of heavy metals from the Hyperion Treatment Plant 5-mile wastewater outfall for the period 1971 through 1975.[1]

SUBSTANCE	MASS EMISSION RATE (METRIC TONS/YEAR)			
	1971[2]	1973[2]	1974[3]	1975[4]
Silver	1.1	14	9.41	9.42
Arsenic	--	5.61	4.76	4.76
Cadmium	25	8.42	9.41	7.53
Chromium	150	136	98.8	59.5
Copper	190	65.5	89.4	90.4
Iron	661	327	301	--
Mercury	2.1	1.22	1.51	0.95
Manganese	16	25.3	9.41	--
Nickel	150	79.5	84.7	71.4
Lead	31	21.1	18.8	14.28
Selenium	--	7.95	9.41	9.52
Zinc	330	117	113	109

[1] All data are originally from the Hyperion Treatment Plant Annual Reports.

[2] From a table in SCCWRP, 1974.

[3] From a table in SCCWRP, 1975a.

[4] Calculated by HDR from the Hyperion Treatment Plant 1975 Annual Report.

Table III-B-7. Annual mass emission rates of selected constituents from the Hyperion Treatment Plant 7-mile wastewater/sludge outfall for the period 1971 through 1975.[1]

SUBSTANCE	MASS EMISSION RATES (METRIC TONS/YEAR)			
	1971[2]	1973[2]	1974[3]	1975[4]
Silver	0.17	5.32	2.61	4.7
Arsenic	0.54	1.80	1.17	1.7
Cadmium	1.51	6.52	8.27	6.9
Chromium	13.4	121	98.4	69
Copper	79.3	90.5	90.5	99
Iron	308	511	513	--
Mercury	0.67	0.93	0.98	0.64
Manganese	10.7	2.46	1.24	--
Nickel	17	23.7	20.2	18.3
Lead	3.34	10.4	7.36	12.1
Selenium	0.37	2.99	2.61	1.6
Zinc	108	180	156	136
Cyanide	1.7	0.73	3.45	3.95

[1] All data are originally from Hyperion Treatment Plant Annual Reports.

[2] From a table in SCCWRP, 1974.

[3] From a table in SCCWRP, 1975a.

[4] Calculated by HDR from the Hyperion Treatment Plant 1975 Annual Report.

Table III-B-8. Annual average concentration of chlorinated hydrocarbons in the HTP effluents in 1975, based on monthly measurements (HTP, 1976).

CHLORINATED HYDROCARBON	CONCENTRATION (μg/l)	
	5-MILE EFFLUENT	7-MILE EFFLUENT
Aldrin	0.12	0.20
BHC	0.15	0.85
Dieldrin	0.11	1.32
Endrin	0.05	0.71
Heptachlor	0.09	0.42
Heptachlor Epoxide	0.03	0.20
Lindane	0.03	0.21
o,p'-DDD	0.06	0.78
p,p'-DDD	0.26	0.78
o,p'-DDE	0.36	0.71
p,p'-DDE	0.87	3.05
o,p'-DDT	0.02	0.24
p,p'-DDT	0.06	0.77
Aroclor 1242	3.92	17.30
Total Identifiable Chlorinated Hydrocarbons (TICH)	6.14	27.47

Note: Aroclor 1242 contributes over half of the total TICH for each effluent.

recognized and utilized in determining what is there and in what concentrations. The present Treatment Division Laboratory data is fully as accurate as that from other laboratories" (Nagano, November 18, 1976).

A comparison of the mass emission rates of two classes of PCB since 1972 is shown in Figures III-B-6 and III-B-7 (the data in these figures come from samples that were collected and analyzed by SCCWRP so that analytical techniques were comparable throughout the sampling period). One of these, 1242 PCB (which is thought to be identical to Aroclor 1242), makes up approximately half the mass of chlorinated hydrocarbons introduced into the Bight. These figures show that HTP has historically released less than half of the total wastewater-derived chlorinated hydrocarbons entering the waters of the Bight. Because of the substantial decreases in the amounts being released from the JWPCP (Whites Point) outfall since 1971, HTP has introduced a progressively larger percentage.

(3) COLIFORM BACTERIA AND VIRUSES IN HTP EFFLUENT. The unchlorinated primary effluent from HTP contains from 4 to 150 million total coliform bacteria (certain intestinal and non-intestinal bacteria released to the ocean primarily by sewage treatment plants and considered an indicator of pollution in ocean waters) per 100 ml with greater than 170,000 fecal streptococci (bacteria from human and warm-blooded animal intestines) per 100 ml (SCCWRP 1975a), and the effluent has always tested positive for *Salmonella* (human disease causing bacterium). In water samples taken near the 5-mile and 7-mile outfalls (unchlorinated effluents), *Salmonella* were found in 8 percent of the samples containing less than 200 total coliform bacteria per 100 ml and in 6 percent of those containing less than 200 fecal coliform bacteria (from intestines of man and warm-blooded animals) per 100 ml, while 38 to 100 percent of the samples containing greater than 1,000 fecal streptococci per 100 ml tested positive for *Salmonella*. The estimated maximum concentration of *Salmonella* in the water near (no exact location given) the HTP outfalls was 0.25 per 100 ml (SCCWRP, 1975a). The mean monthly total coliform counts (MPN/100 ml) in the 5-mile effluent in 1975 ranged from 25 to 43 x 10^6 with maximum values of 240 x 10^6 (HTP, 1976). Fecal coliform counts ranged from <3 x 10^6 to 15 x 10^6 MPN/100 ml with a maximum of 460 x 10^6 MPN/100 ml (fecal maximum > total coliform unexplained). Total coliform counts in the sludge were similar ranging from 21 to 60 x 10^6 MPN/100 ml with a maximum of 460 x 10^6 MPN/100 ml. The sludge fecal coliforms ranged from 2.5 to 11.1 x 10^6 MPN/100 ml with a maximum of 120 x 10^6. The measurements of sludge fecal coliforms were discontinued in October 1975 while those on the 5-mile effluent were continued all year (HTP, 1976).

The viral content of raw wastewater entering HTP is approximately 180 plaque forming units (PFU) per liter. Primary treatment reduces the number to 175 PFU/l and secondary treatment further decreases the number to 6.8 PFU/l (SCCWRP, 1975a). The viral content of the 5-mile effluent (mixed primary and secondary) is 127 PFU/l.

(4) TEMPERATURE OF HTP EFFLUENT. The temperatures of the effluent from both the 5-mile and 7-mile outfalls is usually higher by at least 7 C (16 F) than that of the surrounding water. The precise temperature differential is not known because routine temperature measurements are not made at the depths of the outfalls (57 m and 98 m) but at 43 m, 15 m, and at the surface. Water temperatures ranged from 11 to 14 C (51 to 58 F)

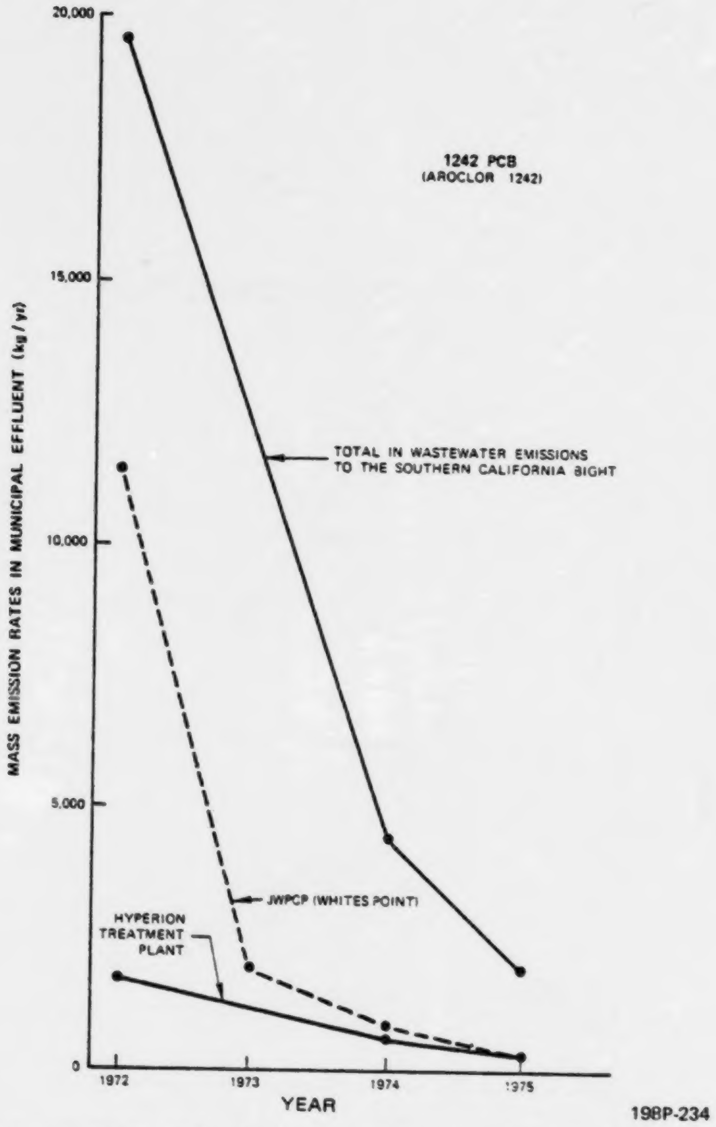


Figure III-B-6. Mass emission rates of 1242 PCB (polychlorinated biphenyl) in sewage treatment plant effluent and sludge released into the Southern California Bight. This compound resembles (and is thought to be) Aroclor 1242 and constituted more than half of the total chlorinated hydrocarbon fraction in municipal wastewater effluents in 1975. This figure shows that Hyperion Treatment Plant has contributed only a small fraction of the total mass emission to the Bight and that total emissions to the Bight decreased by an order of magnitude between 1972 and 1975 (Data from Young et al., 1975).

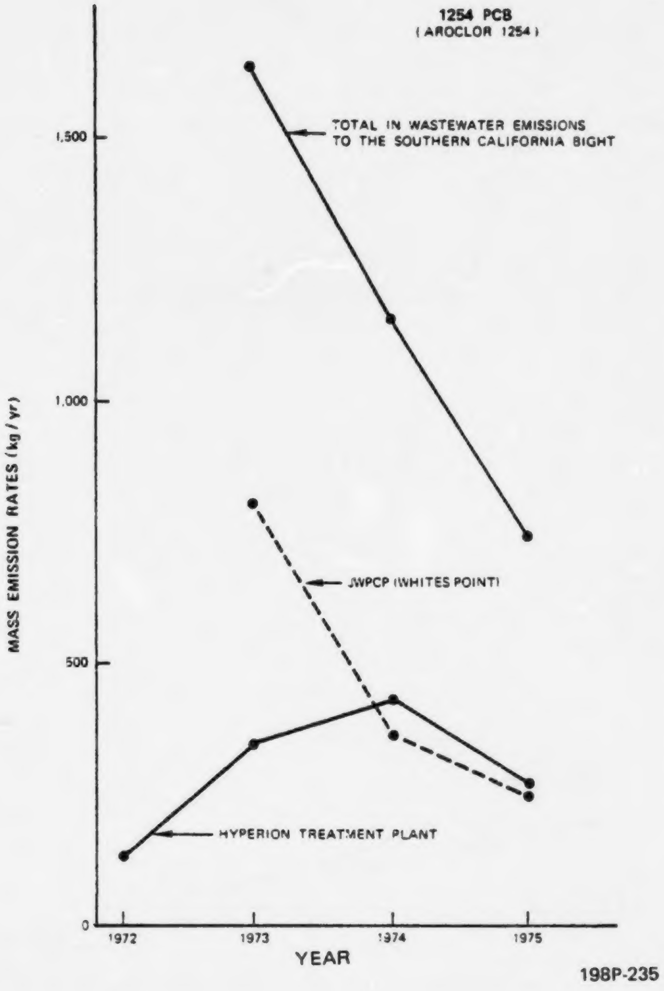
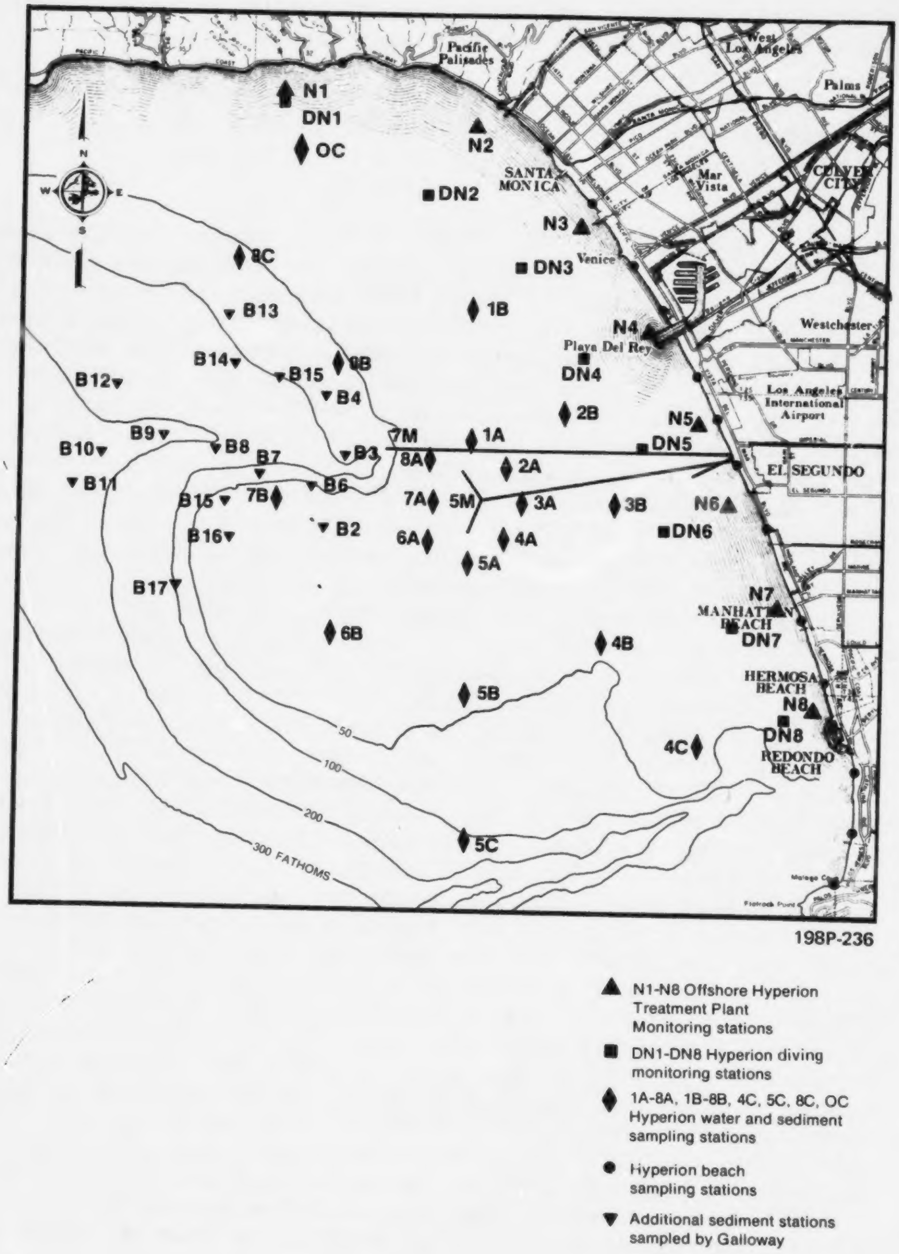


Figure III-B-7. Mass emission rates of 1254 PCB in sewage treatment plant effluent and sludge released into the Southern California Bight. This compound resembles (and is thought to be) Aroclor 1254. This figure shows that Hyperion Treatment Plant contributed less than half of the wastewater-related 1254 PCB in 1975 and considerably less than half in 1973 and 1974 (Data from Young et al., 1975).

during 1974, and they probably don't exceed 13 C (55 F) at the outfalls. The effluent from the 5-mile outfall ranged (in 1974) from 21 C (74 F) in January to 29 C (84 F) in September (DPW, 1975a), and reached 35 C (95 F) in September 1975 (HTP, 1976). The average monthly 7-mile effluent (sludge) temperatures in 1975 ranged from 22 to 31 C (72 to 88 F) peaking at 35 C (95 F).

(5) THE PLUME FROM THE HTP 5-MILE OUTFALL. Because of the lower density of the effluents resulting both from the temperature differentials and from the lower salinity, effluent from both outfalls rises in plumes that drift with the currents and can be distributed over a wide area. In order to assess the distribution of the plume, particularly to find out if it moves shoreward, HTP personnel routinely sample the water column in the vicinity of the 5-mile and 7-mile outfalls weekly at A, B, C, N, and OC points (see Figure III-B-8) at the surface, at 15 m (50 ft), and at 43 m (140 ft) for temperature, dissolved oxygen, salinity, and total coliform bacteria. Coliform bacteria density is the only systematically measured variable in the ocean near the HTP outfalls that allows visualization of the plume. Figures III-B-9 and 10 show concentration contours (MPN/ml) of total coliform bacteria from HTP records for a summer and winter situation. (The winter surface contour from Figure III-B-9 is also plotted on Figure III-B-5). During the winter there is free exchange of water between deep waters and the surface, and the plume occasionally can be detected at the surface. On 21 January 1974, bacteria, some of which appear to have originated from the HTP 5-mile outfall and others which probably were of shoreline (runoff) origin because the samples were taken shortly after a storm, reached the surface. Similar surfacing of the plume may occur throughout the winter, but there is no clear evidence that total coliform bacteria of sewage origin reach the shore although it is quite possible that some may. In summer, the thermocline becomes well established, and there is little transfer of materials between water below the thermocline and that above. Throughout July 1974 total coliform bacteria were detected only twice at the surface in very low levels and only once near the Hyperion outfalls. They were relatively abundant, however, at a depth of 15 m near the level of the thermocline and at 43 m well below it. During both seasons the highest total coliform bacterial densities occurred at the sampling stations within 2 km of the 5-mile outfall. It was not uncommon for relatively high concentrations to occur at stations 6 km away, and occasionally, relatively high concentrations occured at the furthest stations 11 km away, usually due south of the outfall. There is a possibility that the southernmost stations could be influenced by the JWPCP outfalls at Whites Point when a northerly current prevails. The total coliform bacterial concentrations of HTP 5-mile outfall origin are found over a wide area at depths of 15 and 43 m in the Bay.

Total coliform bacteria generally occur in very low concentrations at the shoreline stations; however, higher concentrations occasionally occur (e.g. Figure III-B-10). Weekly sampling of these stations from July 1971 through April 1973 resulted in bacterial counts that ranged from less than 30 to 11,000 MPN/100 ml (DPW, 1973). In each 30 day period less



Pacific Palisades
West Los Angeles
Palms
SANTA MONICA
Mar Vista
CULVER CITY
Venice
Westchester
Playa Del Rey
Los Angeles International Airport
EL SEGUNDO
MANHATTAN BEACH
HERMOSA BEACH
REDONDO BEACH
N
S
W
E
N1
DN1
OC
N2
DN2
N3
DN3
8C
B13
1B
N4
B14
B15
9B
B4
DN4
B12
2B
N5
7M
1A
DN5
B9
B10
B8
B3
8A
2A
B7
B11
B6
7A
5M
3A
3B
N6
B15
7B
B2
6A
4A
DN6
B16
5A
B17
N7
6B
DN7
4B
5B
N8
DN8
4C
50
100
200
300 FATHOMS
5C
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N1-N8 Offshore Hyperion Treatment Plant Monitoring stations
DN1-DN8 Hyperion diving monitoring stations
1A-8A, 1B-8B, 4C, 5C, 8C, OC Hyperion water and sediment sampling stations
Hyperion beach sampling stations
Additional sediment stations sampled by Galloway

Figure III-B-8. Hyperion Treatment Plant routine monitoring stations and additional sediment stations sampled by Galloway (DPW, 1973; Galloway, 1972; SCCWRP, 1973).

than 20 percent of the samples at each station exceeded 1,000 MPN/100 ml, and no sample verified within 24 hours exceeded 10,000 MPN/100 ml as specified in the Ocean Plan (SWRCB, 1972). The shoreline total coliform bacteria concentrations appear to have a positive correlation to rainfall and storm runoff (SCCWRP, 1973). High total coliform counts in the surf usually occurred when storms were more than 20 days apart (probably because of accumulation of bacteria in watercourses between storms which were then flushed out by runoff) and the high concentrations persisted for 3 days.

Unfortunately, total coliform bacteria concentrations are not unequivocal indicators of the distribution and dilution of the plume. The techniques used to detect bacterial presence require that the bacteria be alive, and bacteria do not survive long in sea water. At least half the bacteria in a sample die within 24 hours of exposure to sea water (Vind et al., 1975). Bacteria are also killed rapidly within three meters of the surface by exposure to sunlight (Vind et al., 1975). Consequently, the extent of the plume is likely to be underestimated by the bacterial sampling, particularly at the surface where bacteria are killed by sunlight, and at distances from the outfalls where bacteria die as a function of time as they drift with the current and are preyed upon by other microorganisms.

Measurements of light transmission have also been used to determine the 5-mile effluent plume distribution (Kolpack, 2 March 1977). The data analysis has not been completed at this time, (7 March 1977), but preliminary results indicate that the plume (as indicated by increased suspended solids) does not surface and that it moves to the northwest and southeast. There is also a fairly strong tidal influence on the plume distribution which moves it toward the shore.

(6) DISTRIBUTION OF EFFLUENT FROM THE HTP 7-MILE OUTFALL. The 4.7 mgd of effluent from the 7-mile Hyperion Treatment Plant outfall is composed of a mixture of sludge (screened for floatables) from the HTP anaerobic digester (27 percent), waste activated sludge from the secondary treatment process (21 percent), and secondary treated wastewater from the secondary clarifiers (52 percent) (Bascom, 1975). The effluent is approximately 0.75 percent solids (suspended and settleable). The liquid fraction, being warmer and less dense than the surrounding sea water, undoubtedly rises in a plume in a manner similar to the plume from the 5-mile outfall. Light transmission studies for the 5-mile effluent plume have also provided some data for the sludge discharge, although the data (not yet fully analyzed) do not appear to conclusively define the plume (Kolpack, 2 March 1977). The settleable solids, being heavier than water, settle out of the plume at a rate that is a function of their size and density. Figure III-B-5 includes an artist's conception of the distribution of settleable solids after they are discharged from the 7-mile outfall. There are no diffusers at the end of the outfall so that the effluent is ejected seaward, with the most dense, largest

solids settling out first and progressively finer solids settling out as their forward momentum decreases and their upward momentum stops.

Because of the small volume of liquid effluent from the 7-mile outfall relative to the 340 mgd from the 5-mile outfall, interest in the 7-mile effluent centers on the suspended and settleable solids (including associated chemicals) and their fate.

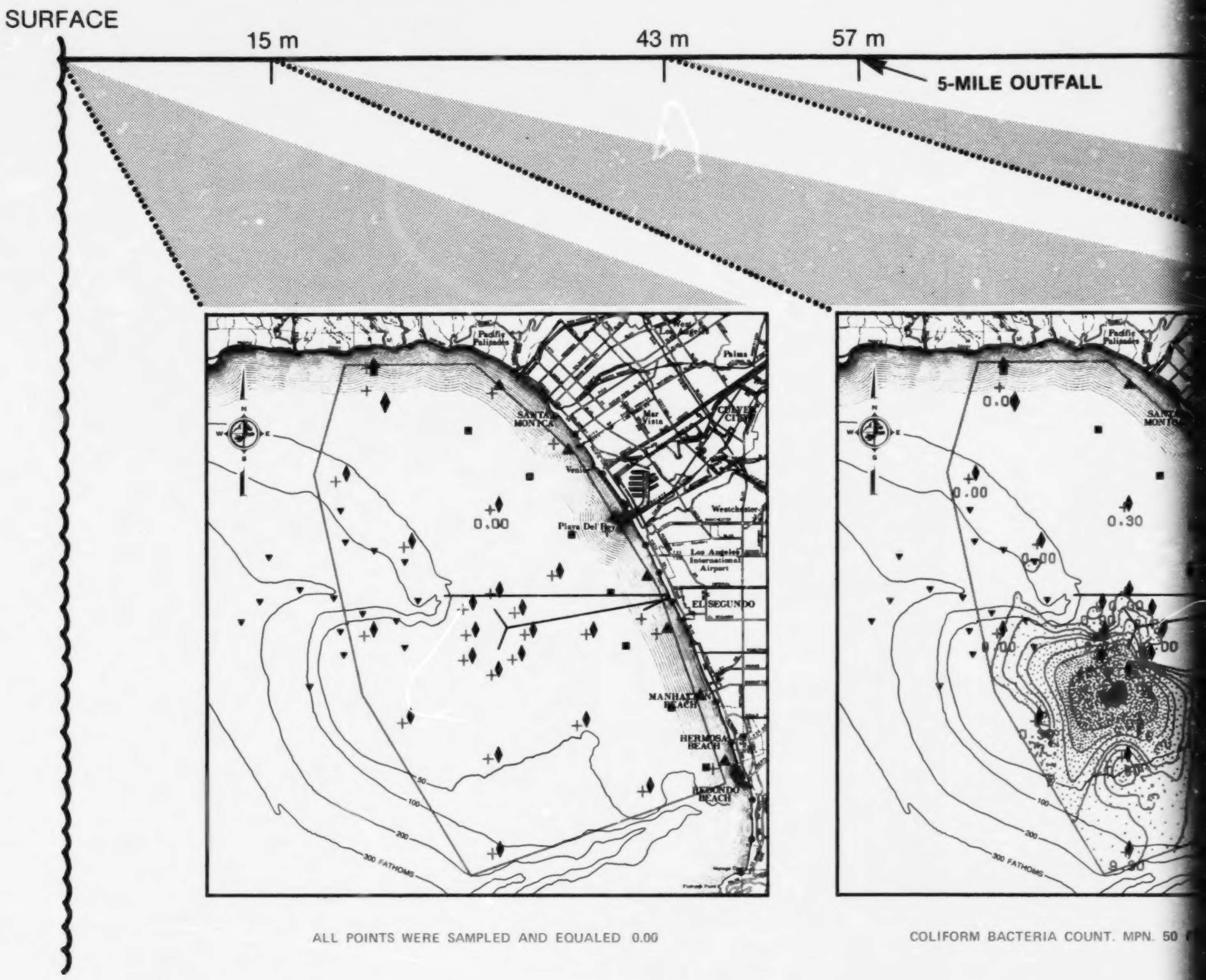
To what extent do the solids settle out and accumulate in the vicinity of the outfall? Are metals and other toxic substances released from the solids prior to settling? After settling? Ever? The following discussion presents evidence related to these questions.

(a) Distribution of Sewage Constituents in the Surface Layers of the Sediments. The distribution and concentration of wastewater constituents in the sediments near the Hyperion outfalls are much better known than their distribution in the water column. The substances that have been measured include chromium, silver, cadmium, copper, nickel, lead, zinc, mercury, arsenic, cobalt, iron, cyanide, chemical oxygen demand, biochemical oxygen demand, sulfides, volatile solids, phenols, total phosphorus, DDT, PCB's, total identifiable chlorinated hydrocarbons, total coliform bacteria, and β-activity (radioactivity). Table III-B-9 lists the studies that have been done near the HTP outfalls.

Hyperion personnel routinely monitor the benthic sediments at the A, B, and C Stations shown in Figure III-B-8 as large diamonds. The eight A stations form an elipse 1 to 2 km from the nearest diffuser port of the 5-mile outfall, the eight B stations form an ellipse approximately 6 km from the 5-mile outfall diffusers, and the three C stations are approximately 11 km from the 5-mile diffusers. Currently, the sediment samples are examined for total nitrogen and benthic organisms only (1975). In the past, however, benthic invertebrate tissues have been analyzed to determine heavy metal concentrations in organisms collected at the A, B, and C stations as well as at the ends of the 5- and 7-mile outfalls and at the eight DN nearshore diving stations. The sediment sampling locations used by Galloway in 1969 through 1971 (Galloway, 1972) are also shown on Figure III-B-8.

The locations sampled by SCCWRP in 1974 and 1975 are shown in Figure III-B-11. At all the SCCWRP locations a benthic grab sampler and sediment traps (devices resembling a funnel into which sediment falls and is collected) were deployed, and at a few, core samples of the benthic grabs were taken as well.

On 24 March 1976 SCCWRP collected a series of single grab samples at each of the 26 stations on a 400 m grid in the immediate vicinity of the 7-mile outfall. These locations are shown on Figures III-B-12, 13, and 14 along with some of the data. The 400 m grid data (previously unpublished and made available expressly for this report by SCCWRP) are by far the most definitive of the distribution of sludge near the 7-mile outfall because of the relatively close spacing of sample points. They represent, however,


SURFACE
15 m
43 m
57 m
5-MILE OUTFALL
Pacific Palisades
Santa Monica
Venice
Mar Vista
Culver City
Palms
West Los Angeles
Playa Del Rey
Westchester
Los Angeles International Airport
El Segundo
Manhattan Beach
Hermosa Beach
Redondo Beach
0.00
0.30
50
100
200
300 FATHOMS
N
S
E
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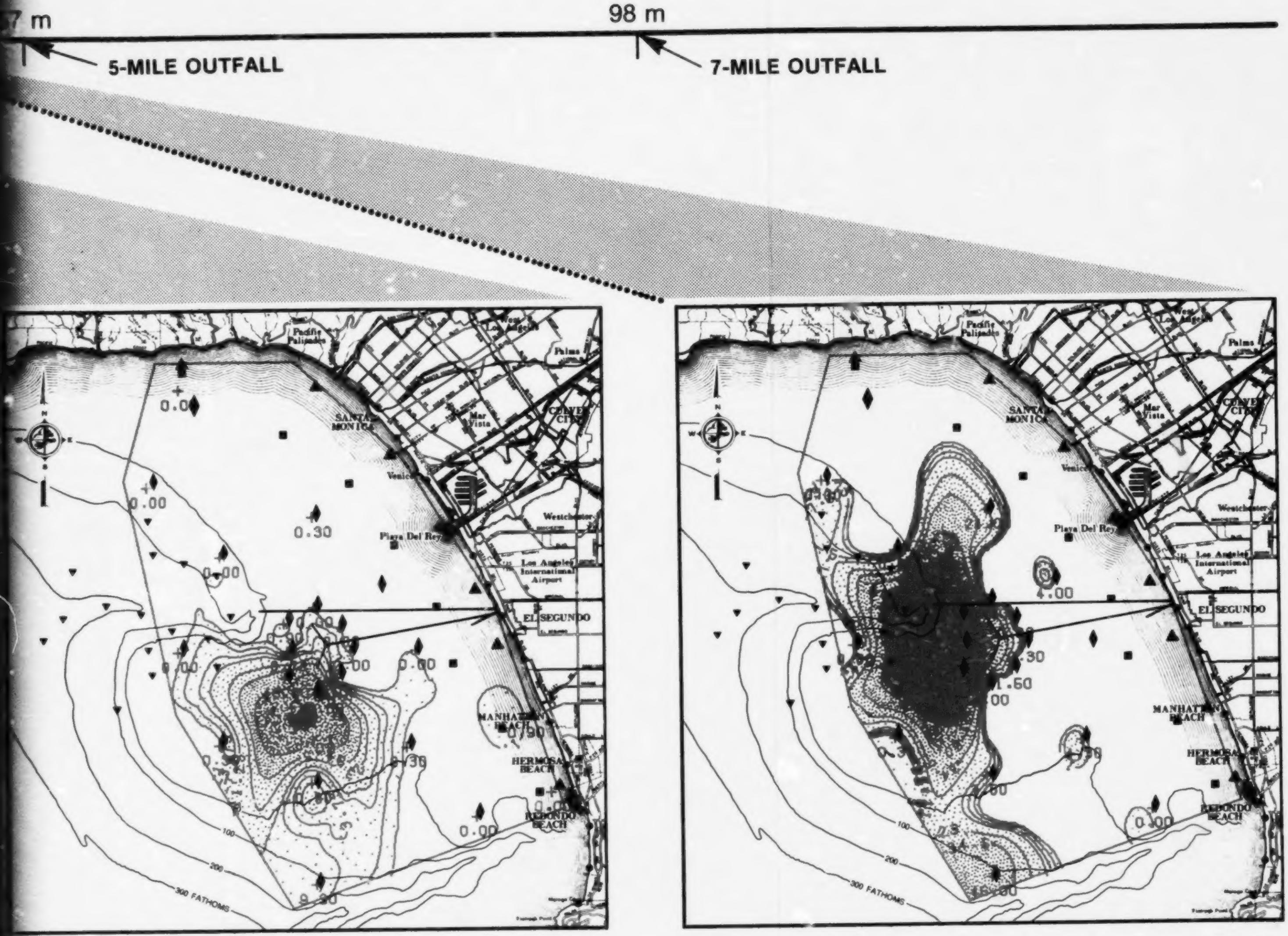
ALL POINTS WERE SAMPLED AND EQUALED 0.00

COLIFORM BACTERIA COUNT. MPN. 50

Figure III-B-9. Total coliform bacteria counts in MPN/ml measured in the surface waters and at depths of 50 and 140 feet in the vicinity of the HTP outfalls on 22 July 1974 (HTP, unpublished data). This figure shows that in the summer, coliform bacteria of sewage origin remain below the thermocline.


98 m
5-MILE OUTFALL
7-MILE OUTFALL
Pacific Palisades
West Los Angeles
Palms
SANTA MONICA
Mar Vista
CULVER CITY
Venice
Westchester
Playa Del Rey
Los Angeles International Airport
EL SEGUNDO
MANHATTAN BEACH
HERMOSA BEACH
REDONDO BEACH
100
200
300 FATHOMS
0.00
0.30
4.00
1.50

COLIFORM BACTERIA COUNT. MPN. 50 FEET, JUL 22, 1974

COLIFORM BACTERIA COUNT. MPN. 140 FEET, JUL 22, 1974

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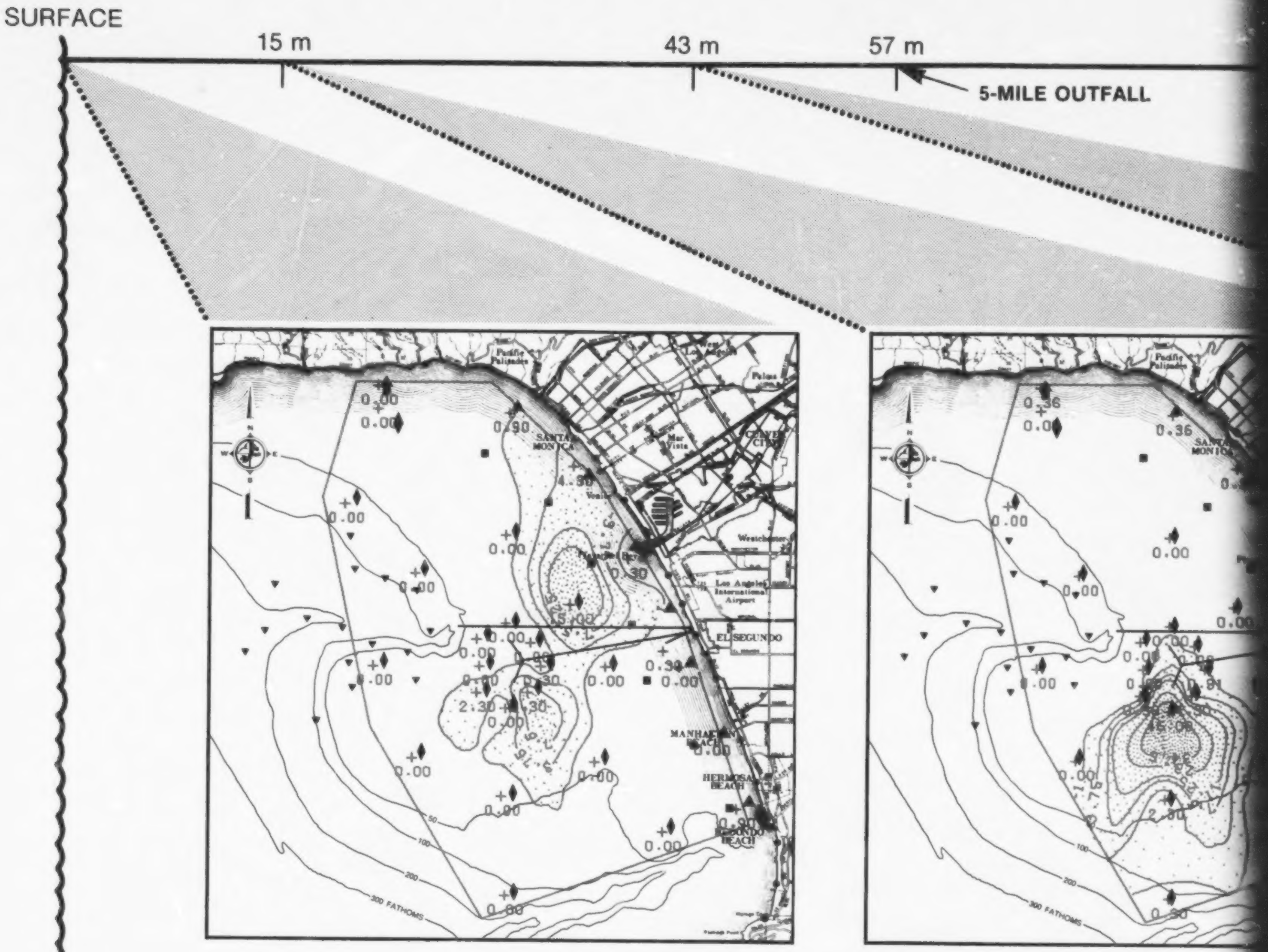
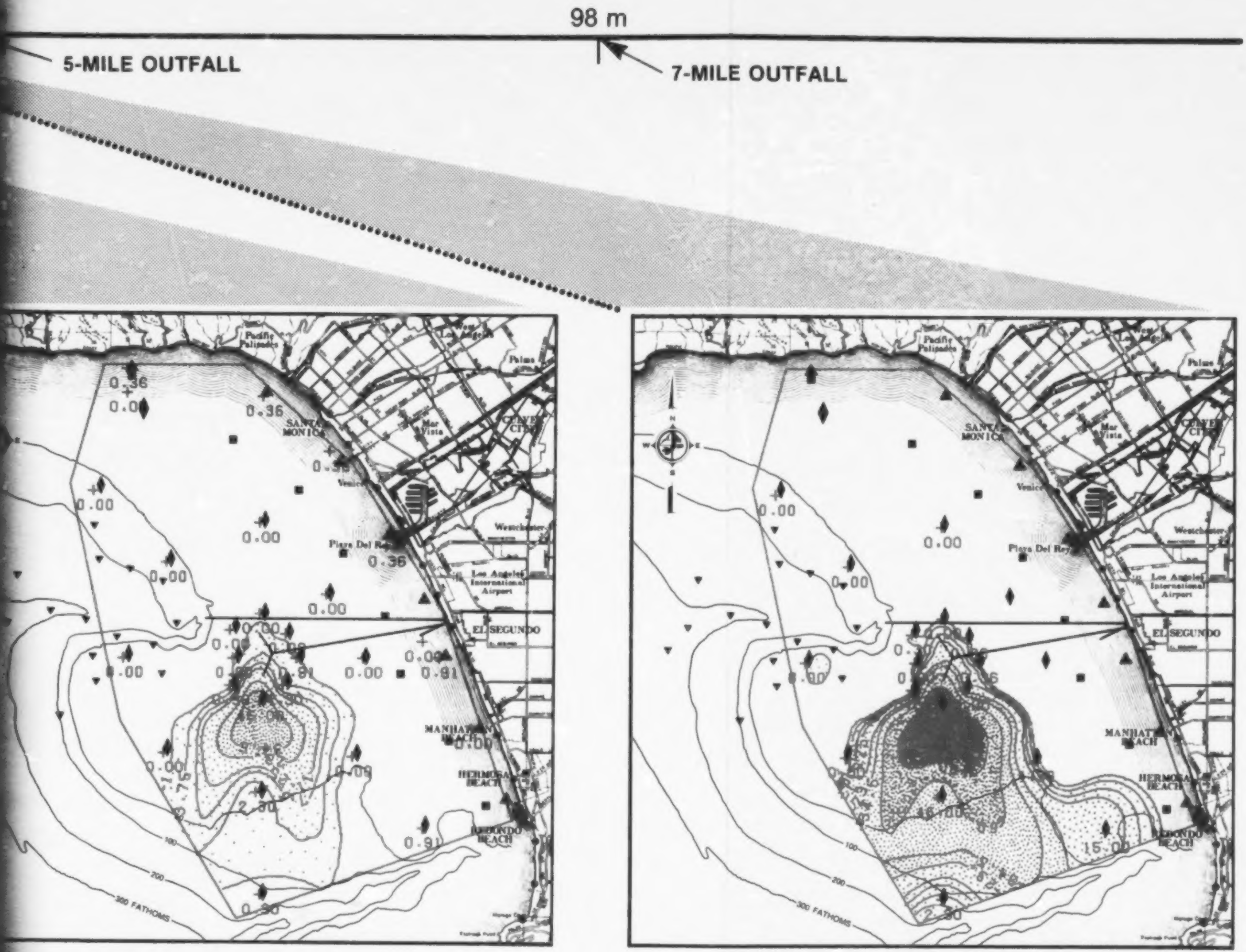

SURFACE
15 m
43 m
57 m
5-MILE OUTFALL
Pacific Palisades
SANTA MONICA
Venice
Playa del Rey
Westchester
Los Angeles International Airport
EL SEGUNDO
MANHATTAN BEACH
HERMOSA BEACH
REDONDO BEACH
CULVER CITY
50
100
200
300 FATHOMS
0.00
0.90
4.30
15.00
2.30
0.30
0.36
46.00

COLIFORM BACTERIA COUNT. MPN. SURFACE, JAN 21, 1974

COLIFORM BACTERIA COUNT. MPN. 50 FE

Figure III-B-10. Total coliform bacteria counts in MPN/ml measured in the surface waters and at depths of 50 and 140 feet in the vicinity of the HTP outfalls on 21 January 1974 (HTP, unpublished data). This figure shows that in winter total coliform bacteria, probably of outfall origin, are found in the surface waters near the outfalls. The surface total coliform concentrations near the shore in the vicinity of Playa del Rey probably resulted from storm runoff from Ballona Creek and other watercourses. Bacteria near shore at Hermosa Beach and Redondo Beach may also be of shoreline origin.


98 m
5-MILE OUTFALL
7-MILE OUTFALL
Pacific Palisades
Santa Monica
Venice
Mar Vista
Culver City
Playa Del Rey
Westchester
Los Angeles International Airport
El Segundo
Manhattan Beach
Hermosa Beach
Redondo Beach
100
200
300 FATHOMS
0.36
0.00
0.91
2.30
15.00

COLIFORM BACTERIA COUNT. MPN. 50 FEET, JAN 21, 1974

COLIFORM BACTERIA COUNT. MPN. 140 FEET, JAN 21, 1974

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only single samples at each of the points. Because of the lack of replicate samples and the large differences in concentration of substances between sampling locations, the density gradients displayed in Figures III-B-12, 13 and 14 should not necessarily be considered accurate representations of the distribution of sludge in the sediments. A series of samples at those locations would be highly desirable.

Table III-B-9. Benthic sediment sampling conducted in the vicinity of the Hyperion Treatment Plant outfalls for the period 1960 to mid-1976.

AGENCY	DATES OF STUDY	TYPE OF STUDY	PARAMETERS[1]
SCCWRP	June 1974 to January 1975	Sediment Trap	Cr, Ag, Cd, Cu, Mn, Ni, Pb, Zn, V.S., COD, BOD
SCCWRP	June 1974 to January 1975	Sediment Core	Cr, Cd, Cu, Ni, Pb, Zn, V.S., COD, P
SCCWRP	January to February 1976	400 m Grid Benthic Grab	Cr, Ag, Cd, Cu, Mn, Ni, Pb, Hg, V.S.
City of L.A. (HTP)	July or November 1972	Sediment Core	Cr, Ag, Cd, Cu, Ni, Pb, Zn, Hg, As, CN, BOD, Phenols, Sulfides, β-Activity, TICH
City of L.A. (HTP)	Semiannual from 1960 to Present	Sediment Cores or Grab Samples	Total Nitrogen
Galloway	1969 to 1971	Sediment Core	Cr, Ag, Cd, Cu, Mn, Ni, Pb, Zn, Ag, Co, Fe
SCCWRP	July 1971 and 1972	Sediment Cores	DDT and PCB
Young et. al. (SCCWRP)	July 1971	Sediment Cores	PCB

[1] Cr = Chromium; As = Arsenic; Ag = Silver; Fe = Iron; Cd = Cadmium; Cu = Copper; Co = Cobalt; Mn = Manganese; Ni = Nickel; Pb = Lead; Zn = Zinc; Hg = Mercury; V.S. = Volatile Solids (an index of organic content); COD = Chemical Oxygen Demand; BOD = Biochemical Oxygen Demand; P = Total Phosphorus; CN = Cyanide; β-Activity = A type of radioactivity; TICH = Total Identifiable Chlorinated Hydrocarbons; DDT = A chlorinated hydrocarbon; PCB = Polychlorinated biphenyls (a class of chlorinated hydrocarbon).

The sludge has visibly changed the physical character of the bottom sediments within a few km off the end of the outfall. Figure III-B-12 gives a subjective judgment of the sediment characteristics on 25 March 1976. The two areas marked black sand, each 400 m from the outfall, consisted of fluffy black material with relatively dense (but unquantified in this study) populations of the pollution-tolerant polychaete worm, *Capitella capitata,* and the clam, *Solemya*. The fluffy black sand did not resemble bottom sediment collected elsewhere and is evidently of sewage origin. It had an organic content of 3.0 to 5.7 percent volatile solids which is somewhat higher than the estimated background levels of 2 percent. Apparently the heavier grit and sand settle out near the outfall, and the organic fraction floats out to between 700 and 1,000 meters from the outfall

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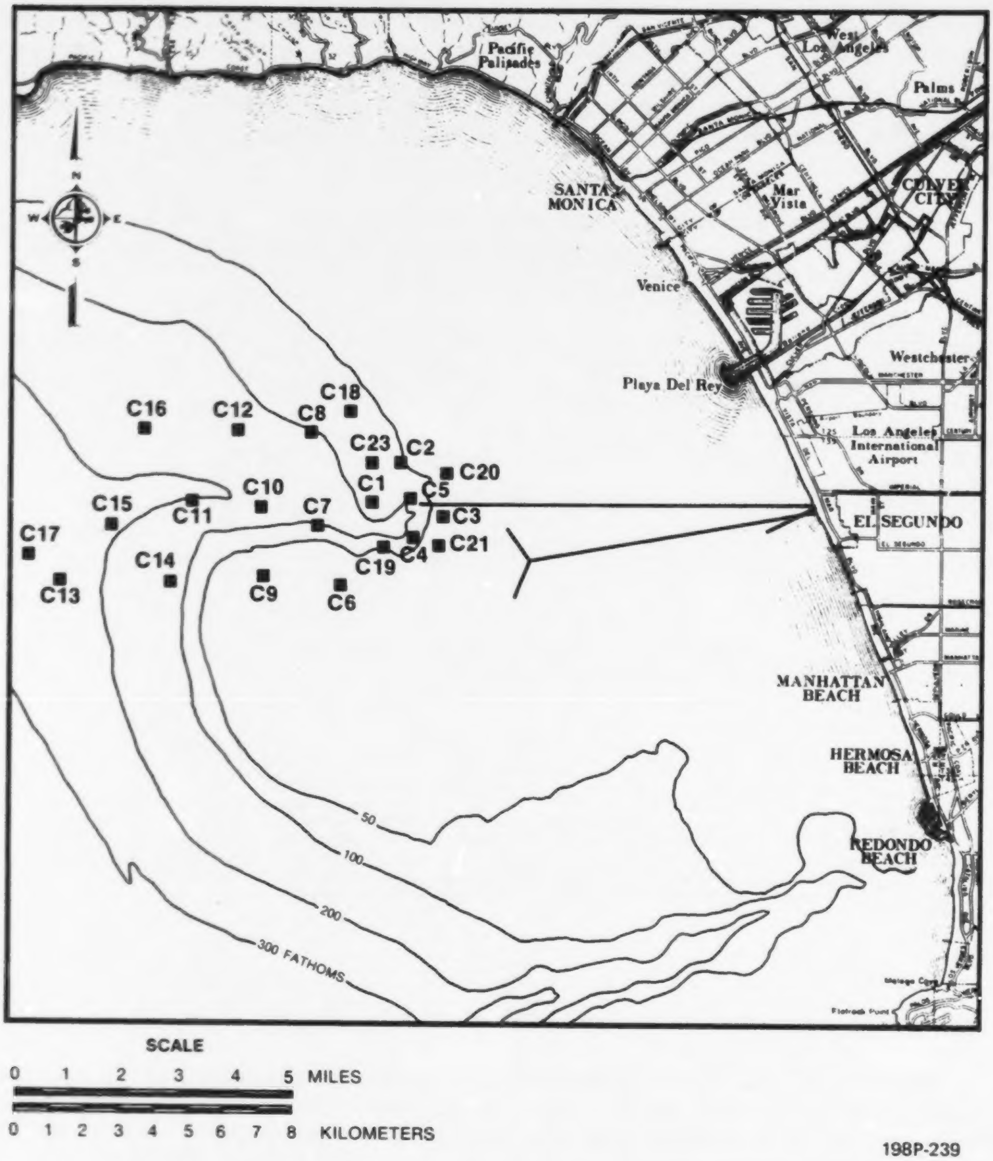
Pacific Palisades
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Westchester
Playa Del Rey
Los Angeles International Airport
EL SEGUNDO
MANHATTAN BEACH
HERMOSA BEACH
REDONDO BEACH
N
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C23
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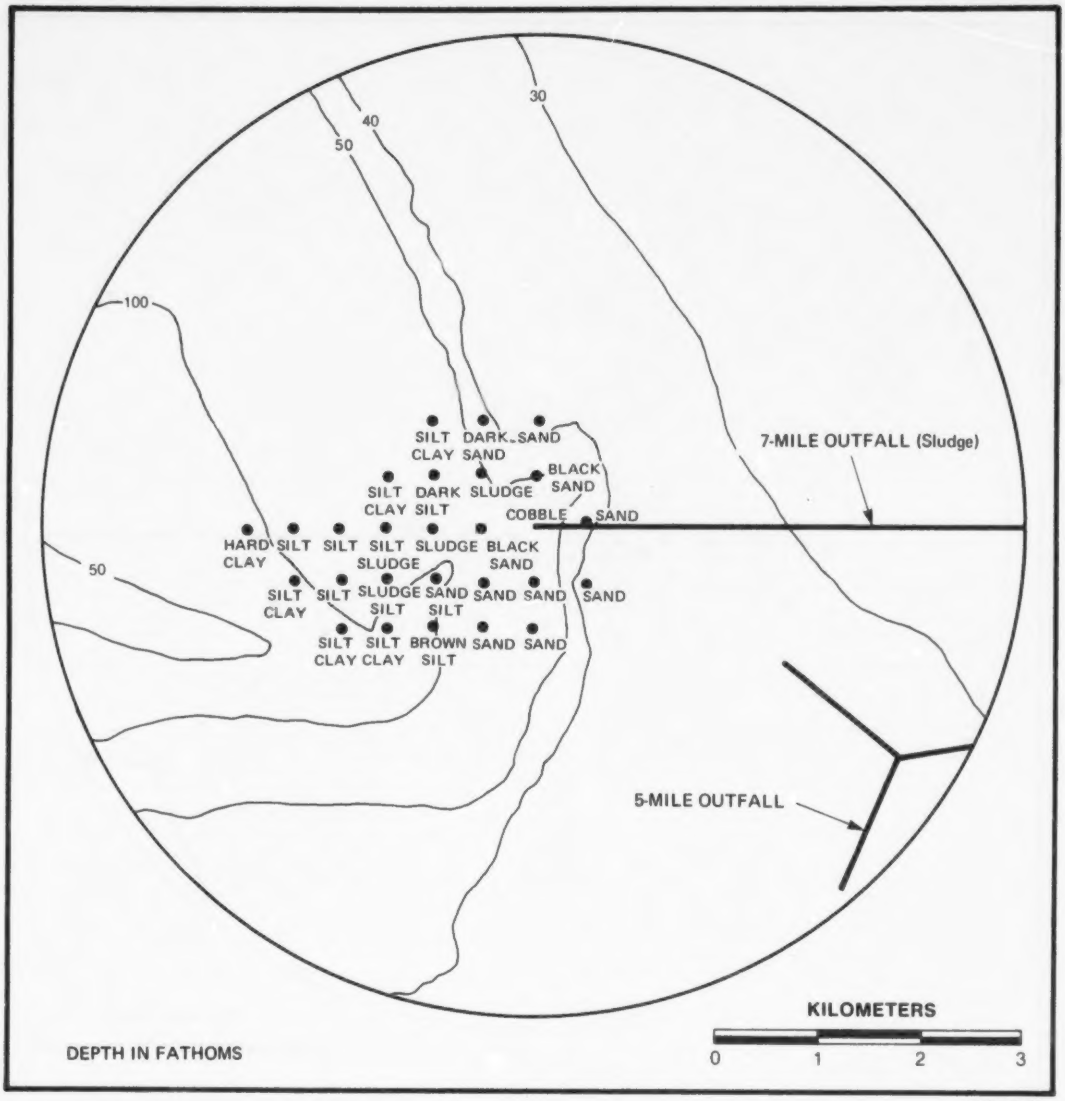
C20
C1
C5
C10
C15
C11
C7
C3
C17
C21
C4
C19
C14
C13
C9
C6
50
100
200
300 FATHOMS
SCALE
0 1 2 3 4 5 MILES
0 1 2 3 4 5 6 7 8 KILOMETERS
198P-239

Figure III-B-11. Location of SCCWRP sediment sampling stations near the HTP 7-mile outfall for 1974 and 1975 (SCCWRP, unpublished data).


30
40
50
100
50
SILT CLAY
DARK SAND
SAND
BLACK SAND
SILT CLAY
DARK SILT
SLUDGE
COBBLE
SAND
HARD CLAY
SILT
SILT
SILT SLUDGE
SLUDGE
BLACK SAND
SILT CLAY
SILT
SLUDGE SILT
SAND SILT
SAND
SAND
SAND
SILT CLAY
SILT CLAY
BROWN SILT
SAND
SAND
7-MILE OUTFALL (Sludge)
5-MILE OUTFALL
KILOMETERS
0
1
2
3
DEPTH IN FATHOMS

198P-240

Figure III-B-12. Sediment type judged subjectively at the time of sampling (25 March 1976) by SCCWRP personnel (unpublished data provided to HDR by H. Schafer, SCCWRP).

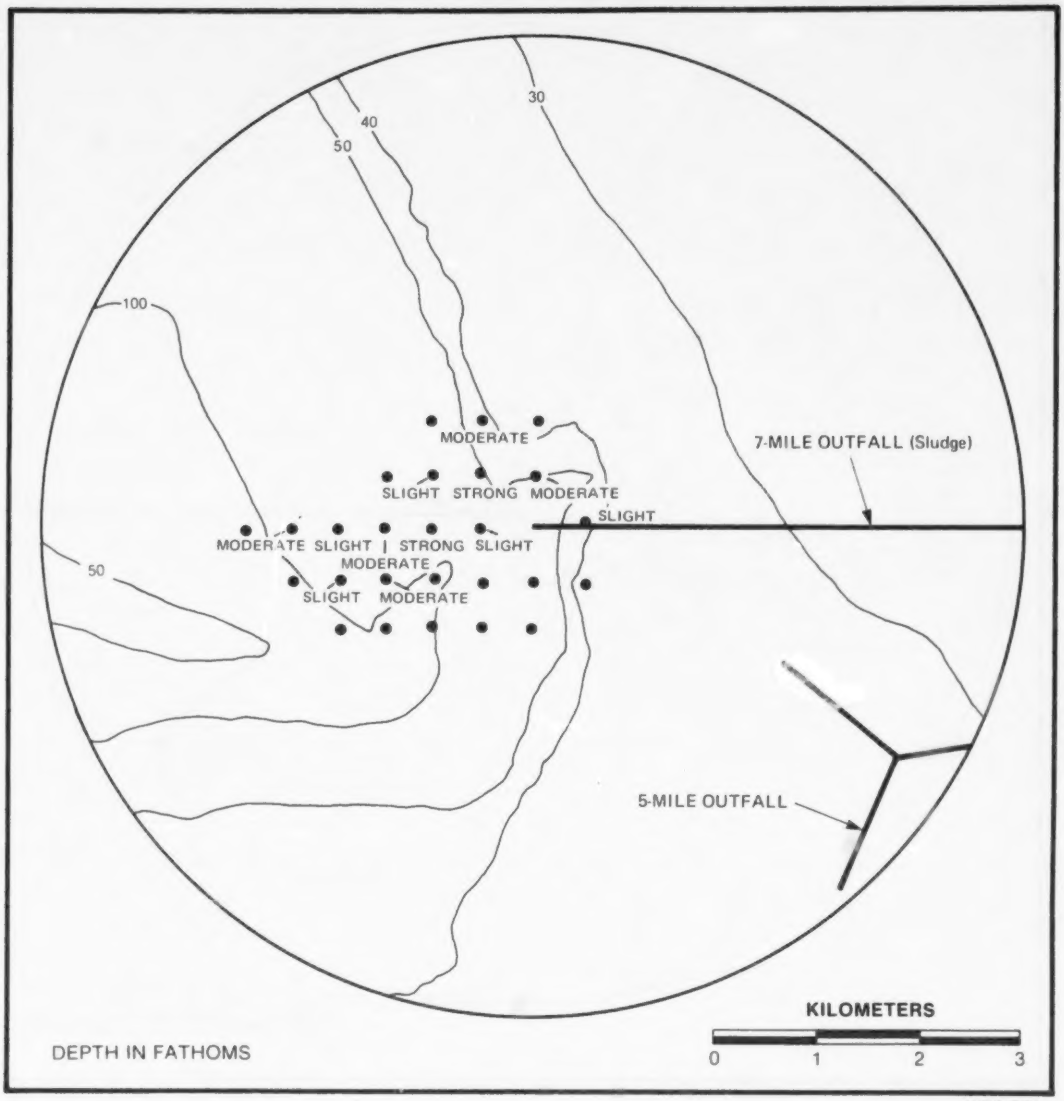
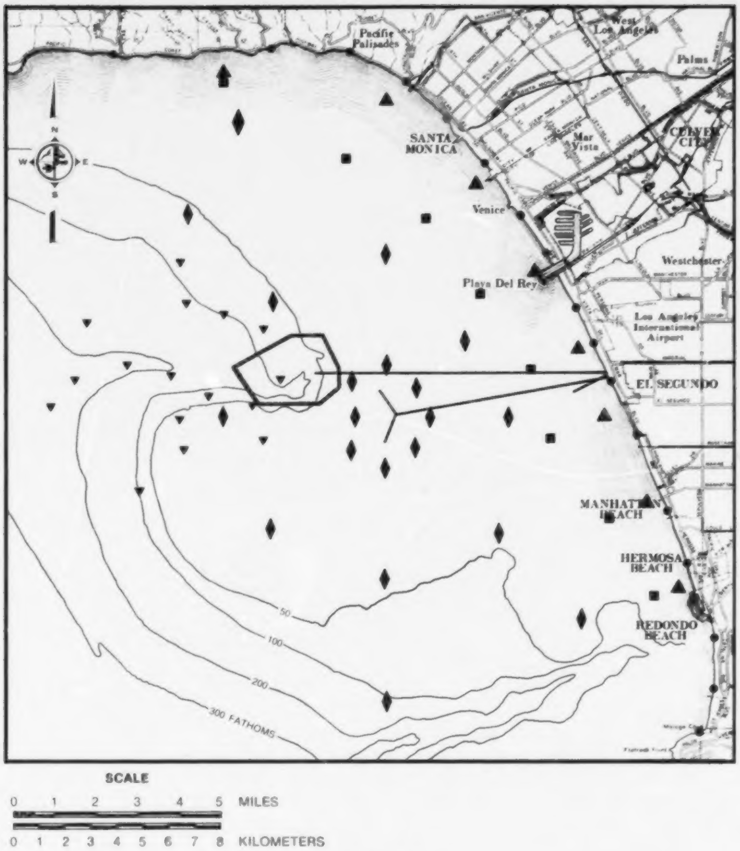
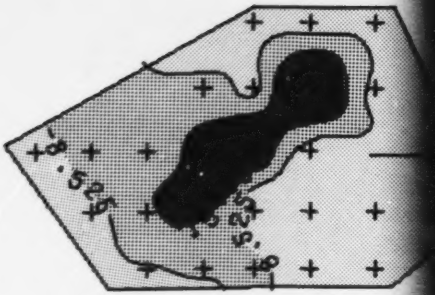

30
40
50
100
50
MODERATE
SLIGHT
STRONG
MODERATE
SLIGHT
MODERATE
SLIGHT
STRONG
SLIGHT
MODERATE
SLIGHT
MODERATE
7-MILE OUTFALL (Sludge)
5-MILE OUTFALL
KILOMETERS
0
1
2
3
DEPTH IN FATHOMS
198P-241

Figure III-B-13. Sulfide smell measured subjectively at the time of sampling (25 March 1976) by SCCWRP personnel (unpublished data provided to HDR by H. Schafer, SCCWRP).

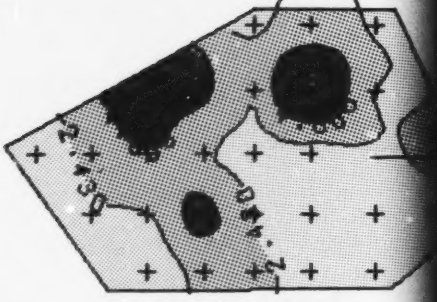

Pacific Palisades
West Los Angeles
Palms
SANTA MONICA
Mar Vista
CULVER CITY
Venice
Westchester
Playa Del Rey
Los Angeles International Airport
EL SEGUNDO
MANHATTAN BEACH
HERMOSA BEACH
REDONDO BEACH
N
W
E
S
50
100
200
300 FATHOMS
SCALE
0 1 2 3 4 5 MILES
0 1 2 3 4 5 6 7 8 KILOMETERS

LOCATION



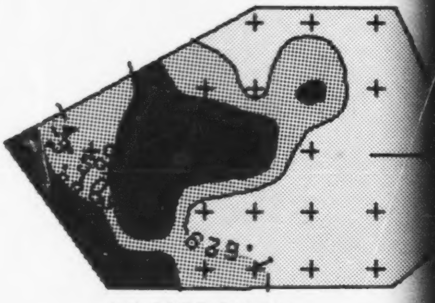
(a) VOLATILE SOLIDS

HIGH = 30.2%
LOW = 2.2%



(d) CHROMIUM

HIGH = 864 ppm
LOW = 36 ppm



(g) MERCURY

HIGH = 6.07 ppm
LOW = 0.149 ppm

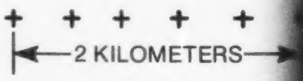
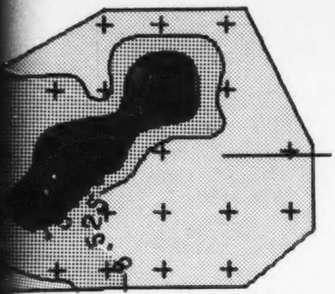
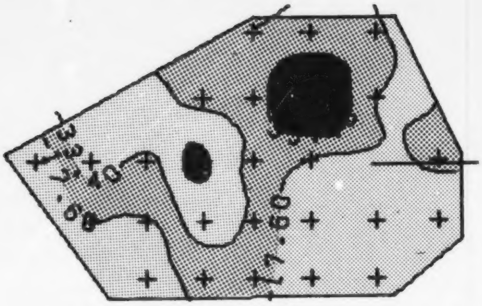

2 KILOMETERS

Figure III-B-14. Concentration gradients in mg/dry kg of wastewater constituents in the sediments near the HTP 7-mile outfall. Data are from single grab samples collected by SCCWRP at 26 stations on a 400 m grid in March 1976. The plotting routine used is described in Appendix III.A (unpublished SCCWRP data provided to HDR by H. Schafer).



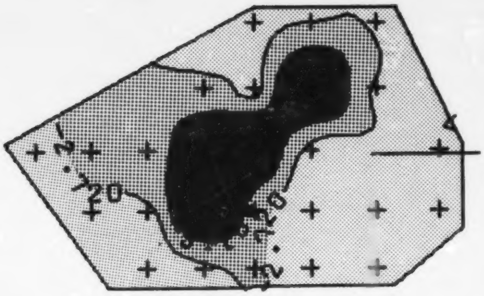
VOLATILE SOLIDS

HIGH = 30.2%
LOW = 2.2%


7.40
7.60
17.60

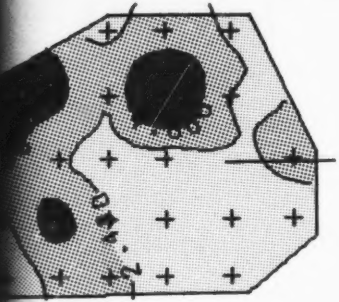
(b) CADMIUM

HIGH = 65 ppm
LOW = 1.8 ppm



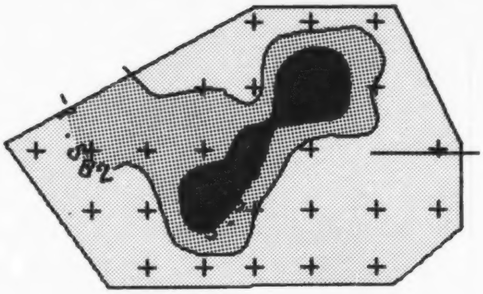
(c) COPPER

HIGH = 1010 ppm
LOW = 26 ppm



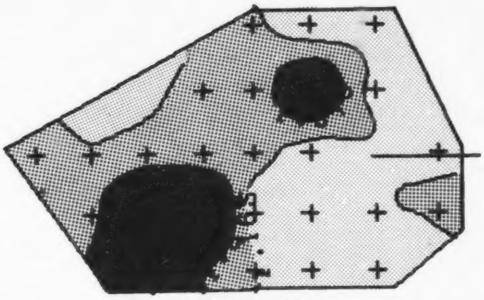
CHROMIUM

HIGH = 864 ppm
LOW = 36 ppm



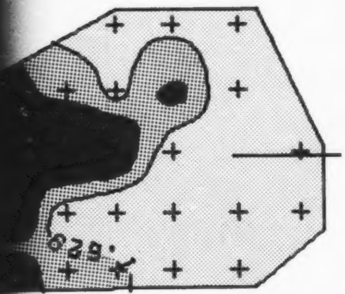
(e) LEAD

HIGH = 597 ppm
LOW = 12 ppm



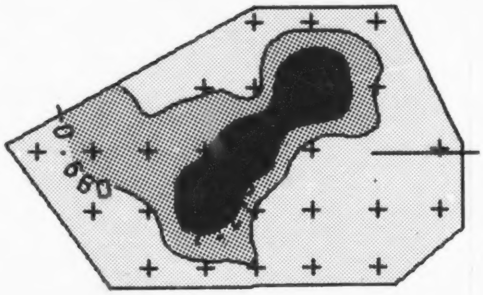
(f) MANGANESE

HIGH = 328 ppm
LOW = 60ppm



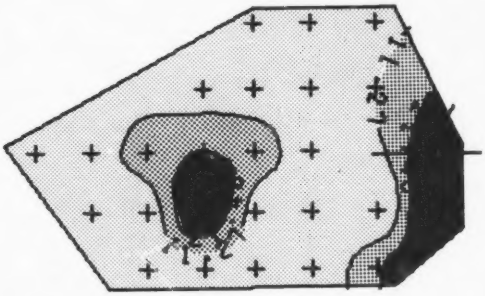
MERCURY

HIGH = 6.07 ppm
LOW = 0.149 ppm



(h) NICKEL

HIGH = 231 ppm
LOW = 11 ppm



(i) SILVER

HIGH = 32 ppm
LOW = 1.1 ppm

1 P.

2 KILOMETERS

before settling. The two areas marked sludge consisted of a black muck mixed with what appeared to be chopped vegetation, hair, bandaids, cigarette butts, and other relatively non-degradable sewage-derived objects.

Figure III-B-13 shows another subjective indication of the presence of sludge, a sulfide smell in the enriched anaerobic (reduced) sediments. A sulfide smell is not characteristic of sediments away from sewage outfalls. Figure III-B-14 shows the location of the 400 m grid sampling relative to the 7-mile outfall and includes density gradients for all of the sediment constituents that were measured. The isoconcentration lines were calculated and plotted by computer using a plotting routine described in Appendix III.A. For the 400 m grid data the isopleth levels were determined for each constituent using the formulae:

$$\text{Isopleth 1} = 0.25 \left(C_{max} - C_{min}\right) + C_{min}$$

$$\text{Isopleth 2} = 0.50 \left(C_{max} - C_{min}\right) + C_{min}$$

$$\text{Isopleth 3} = 0.75 \left(C_{max} + C_{min}\right) + C_{min}$$

where C_{max} and C_{min} were the highest and lowest values in the data set.

Isopleths were selected relative to the range of each data set in this manner so that if constituents in the sediments were distributed in the same way relative to one another, the isopleths would be similar. These data demonstrate clearly that all of the measured effluent constituents accumulate to their highest concentrations within 2 km of the 7-mile outfall, and that the majority of the enriched sediments are contained within an area of a few square km. The density distributions of all of the constituents (except silver) are very similar with an area of high concentration 0.5 km WNW of the end of the sludge pipe, and another between 1.2 and 2.0 km W or WSW from the end of the pipe. Inspection of the isopleths on the 400 m grid indicate that they are almost interchangeable from constituent to constituent. The steep concentration gradients within this small area make it clear that a relatively fine sampling grid, such as the 400 m grid used for these samples, or finer, is desirable for assessing the distribution of sewage constituents in the bottom sediments.

Isopleths for all the other data sets (HTP, 1973; Galloway, 1972; SCCWRP, 1974 and 1975a) were selected using the formulae:

$$\text{Isopleth 1} = 0.15 \left(C_{max} - C_{min}\right) + C_{min}$$

$$\text{Isopleth 2} = 0.85 \left(C_{max} - C_{min}\right) + C_{min}$$

Isopleth 3 = mean of all values in the data set.

This method was selected because the location of the mean isopleth relative to the other two is indicative of whether the data are evenly distributed or skewed. If the mean and 0.15 isopleth are close together, it indicates that the high value is very high relative to the rest of the values (i.e., a very strong peak of concentration). Conversely, if the mean isopleth is near the 0.85 isopleth, then the peak concentration is

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spread out relative to the data set being considered. The plotting routine was constrained to an area in the vicinity of the data set which was being plotted , and the constraint is shown as a polygon within which isopleths are drawn. Figure III-B-15 shows the areal limits of the isoconcentration lines drawn for the three main data sets. For some of the sediment constituents in which data from only one or two studies were available, the three levels of computer drawn isopleths are shown. Figure III-B-16 shows data from the HTP 1972 sample grabs for sulfides, arsenic, cyanide, and phenols.

All of these constituents are most concentrated in the vicinity of the outfalls. The levels of the isopleths in mg/dry kg (ppm) can be read from the figures, and the highest and lowest values recorded in the entire study are also included. Figure III-B-17 shows that the distribution of both chemical and biochemical oxygen demand, measures of oxygen demand for degradation of organic matter, are also concentrated in the vicinity of the sludge outfall. Figure III-B-18 shows concentrations of volatile solids in core samples and in sediment trap samples. The volatile solids concentration has been shown to be correlated with sediment organic content (SCCWRP, 1975a), and the volatile solids plots show that organics, both in the suspended solids and in the bottom sediments, are localized in the vicinity of the 7-mile outfall (although there were no samples taken inshore from the outfall). Evidently, the organic constituents of the sludge only accumulate at the head of Santa Monica Canyon and not down in the canyon.

For the remaining sewage-derived constituents of the sediments that have been measured (DDT, PCB's, and heavy metals) the data from the various studies are presented on single base maps for each constituent, and single isoconcentration lines were chosen from each study. The levels chosen were as close to 10 times the estimated background concentration as the data allowed. The results are displayed in Figures III-B-19 through 28. On these figures, the areas of greatest overlap are the areas in which most studies showed high concentrations of the substance in question. The areas of highest concentration of sewage derived sediments are off the end of the 7-mile sludge outfall. There have been no studies since the HTP 1972 samples that have explored a sample grid inshore from the end of the 7-mile outfall so that present metal and other toxicant distributions between the end of the 7-mile outfall and the shoreline are not known.

(b). Sediment Trap Data. The concentrations of metals in the sediment traps are remarkably similar to those in sediment cores taken concurrently. The maximum values observed are comparable and the distributions are similar. The main systematic difference between the two sets of data is that the concentration of metals in sediments taken in the traps is generally high over a much larger area than that taken in the cores. A possible explanation is that sediments collected in the traps at a distance from the outfall may have been transported to that

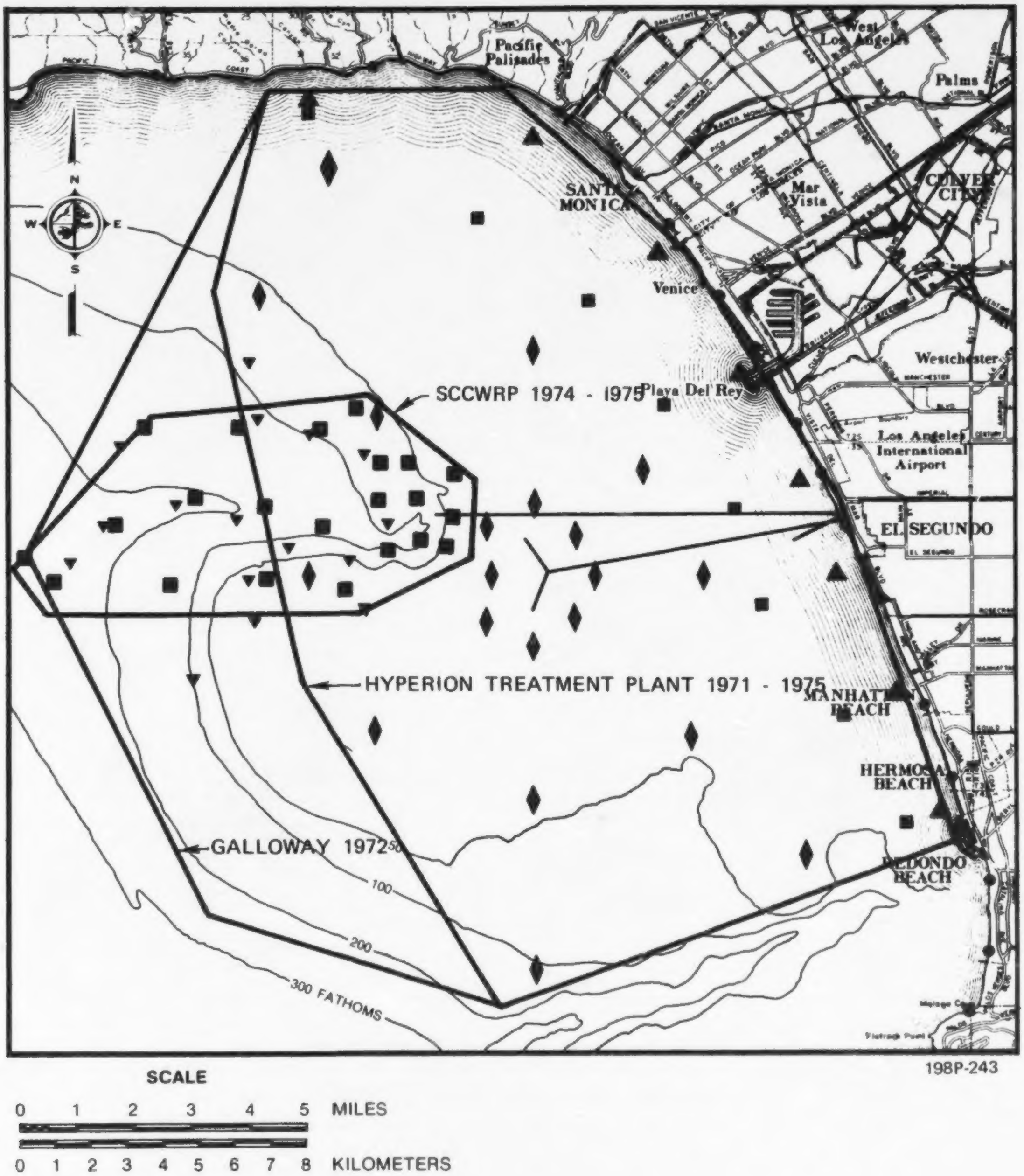
Pacific Palisades
West Los Angeles
Palms
SANTA MONICA
Mar Vista
CULVER CITY
Venice
Westchester
Playa Del Rey
Los Angeles International Airport
EL SEGUNDO
MANHATTAN BEACH
HERMOSA BEACH
REDONDO BEACH
SCCWRP 1974 - 1975
HYPERION TREATMENT PLANT 1971 - 1975
GALLOWAY 1972
50
100
200
300 FATHOMS
N
S
E
W
198P-243
SCALE
0 1 2 3 4 5 MILES
0 1 2 3 4 5 6 7 8 KILOMETERS

Figure III-B-15. Sediment stations sampled by HTP (diamonds and small squares near shore), by SCCWRP during 1974 and 1975 (large squares off the end of the 7-mile outfall), and by Galloway during 1971 (all HTP stations plus the small inverted triangles off the 7-mile outfall). The polygons indicate the areal constraint imposed on the computer-drawn isoconcentration lines in the figures that follow.

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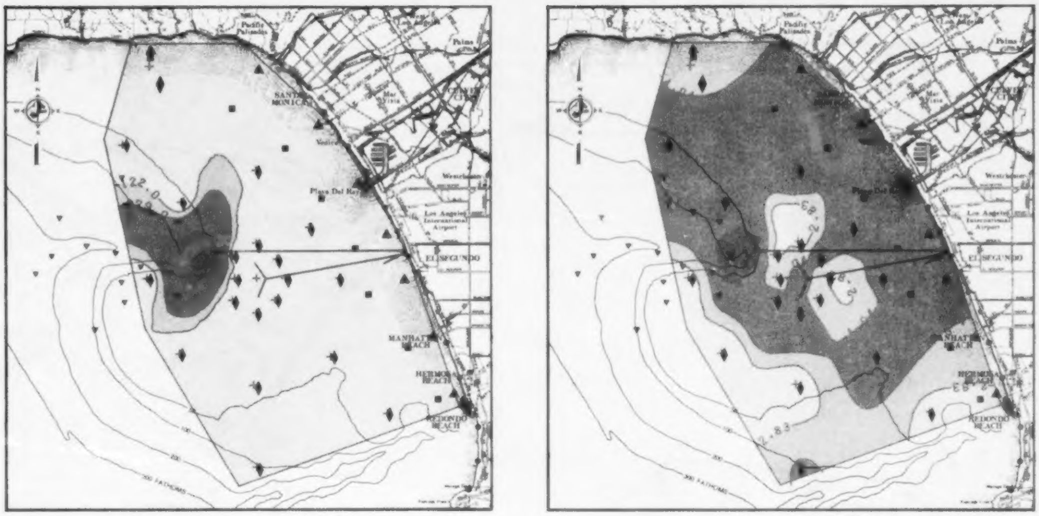
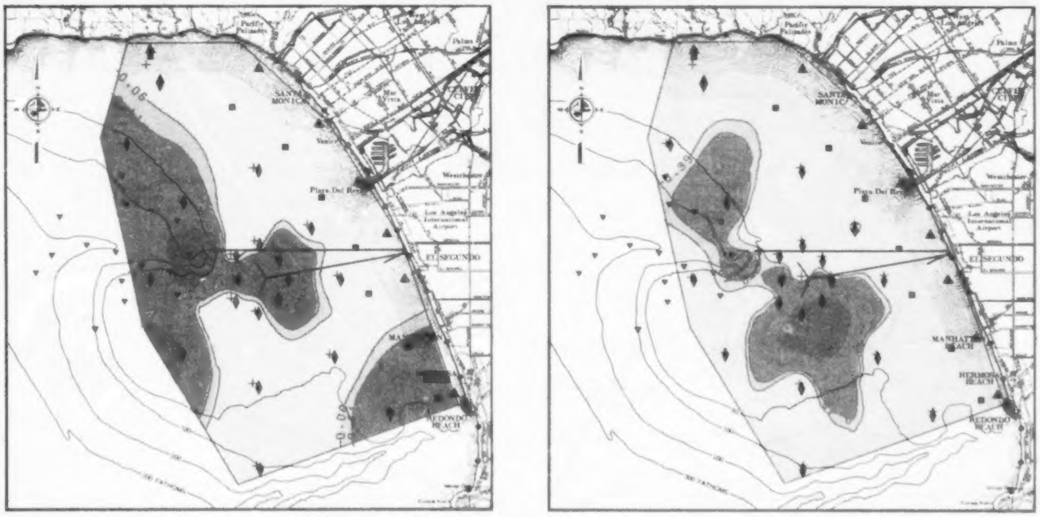

Pacific Palisades
Palms
SANTA MONICA
Venice
Mar Vista
Culver City
Westchester
Playa Del Rey
Los Angeles International Airport
EL SEGUNDO
MANHATTAN BEACH
HERMOSA BEACH
REDONDO BEACH
22.0
2.83
300 FATHOMS

SULFIDES
HIGH = 2740 ppm
LOW = 1.7 ppm

ARSENIC
HIGH = 8.61 ppm
LOW = 0.53 ppm

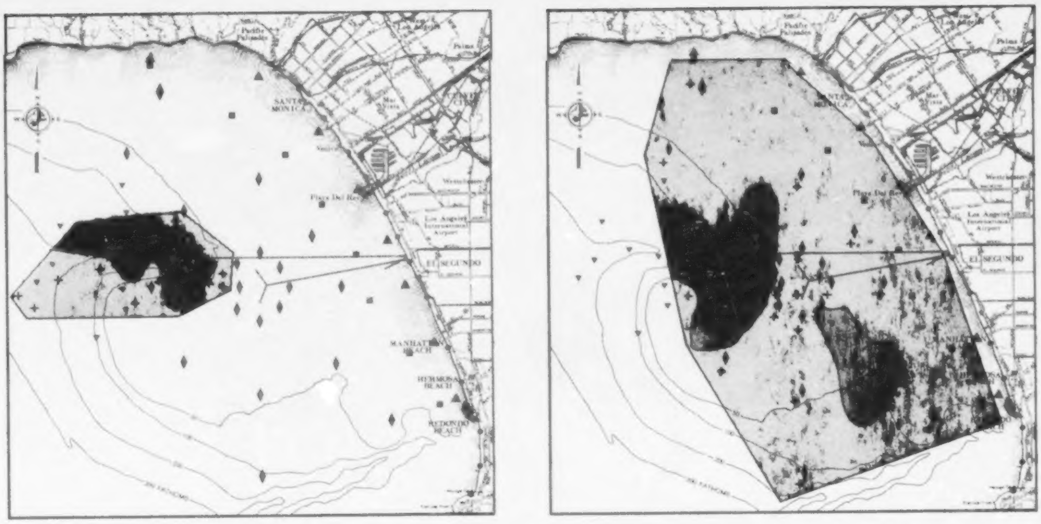

Pacific Palisades
Palms
SANTA MONICA
Venice
Mar Vista
Culver City
Westchester
Playa Del Rey
Los Angeles International Airport
EL SEGUNDO
MANHATTAN BEACH
HERMOSA BEACH
REDONDO BEACH
0.05
0.00
300 FATHOMS

CYANIDES
HIGH = 0.37 ppm
LOW = 0

PHENOLS
HIGH = 1.3 ppm
LOW = 0

198P-244

Figure III-B-16. Concentrations in mg/dry kg of sulfides, arsenic, cyanide, and phenols in sediments in the vicinity of the HTP 7-mile outfall. Locations at which samples were taken are shown by a +. The isopleths are computer-drawn at the mean and 15 and 85 percentile concentrations for each data set, and intensity of color is indicative of concentration. The highest and lowest values from each data set are indicated on the figures. Except for phenols, the highest value was from the station at the end of the 7-mile outfall (data from DPW, 1973).

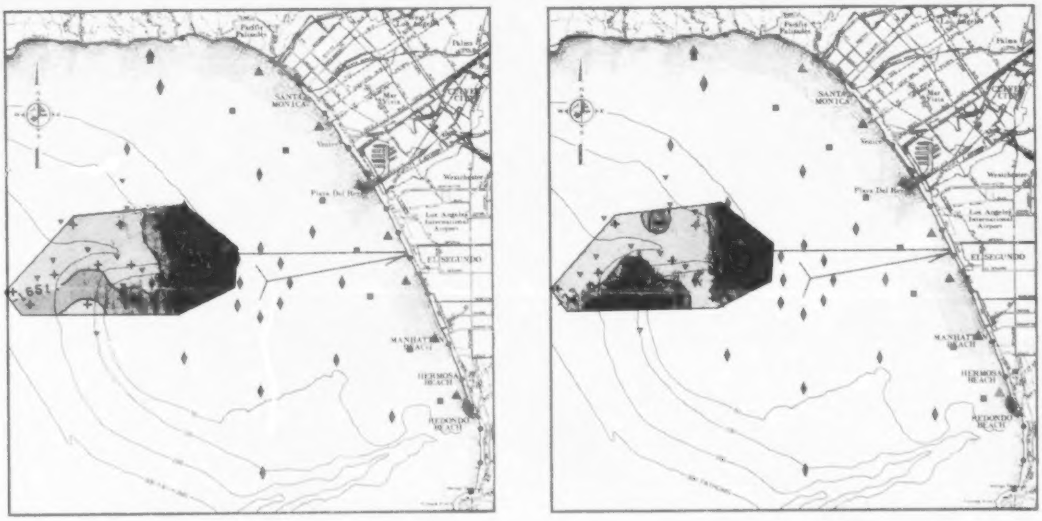

Pacific Palisades
Santa Monica
Venice
Mar Vista
Palms
Playa Del Rey
Westchester
Los Angeles International Airport
El Segundo
Manhattan Beach
Hermosa Beach
Redondo Beach

SCCWRP, unpublished data

COD, CORE
HIGH = 501,000
LOW = 14,394

SCCWRP, unpublished data

BOD, CORE
HIGH = 12,540
LOW = 357


Pacific Palisades
Santa Monica
Venice
Mar Vista
Palms
Playa Del Rey
Westchester
Los Angeles International Airport
El Segundo
Manhattan Beach
Hermosa Beach
Redondo Beach
159

SCCWRP, unpublished data

COD, SEDIMENT TRAP
HIGH = 676,000
LOW = 75,000

SCCWRP, unpublished data

BOD, SEDIMENT TRAP
HIGH = 38,800
LOW = 1,740

198P-245

Figure III-B-17. Chemical and biochemical oxygen demand in mg/dry kg in the sediments in the vicinity of the HTP 7-mile outfall. Locations at which samples were taken are shown by a +. The isopleths are computer-drawn at the mean and 15 and 85 percentile concentrations for each data set, and intensity of color is indicative of concentration. The highest and lowest values from each data set are indicated on the figures. Except for COD, the highest value was from the station at the end of the 7-mile outfall (SCCWRP, unpublished data; DPW, 1973).

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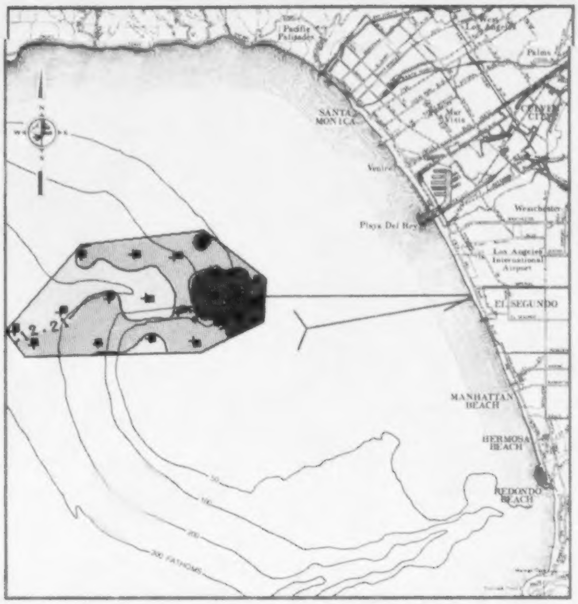
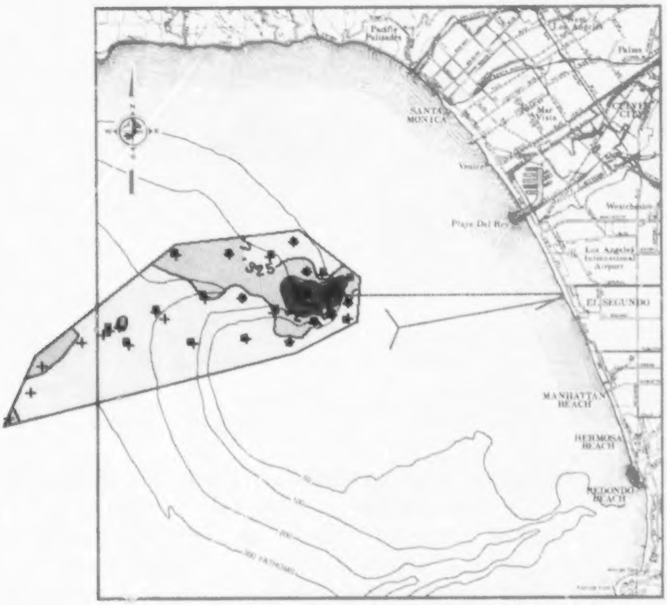

Pacific Palisades
SANTA MONICA
Mar Vista
Palms
Culver City
Venice
Playa Del Rey
Westchester
Los Angeles International Airport
EL SEGUNDO
MANHATTAN BEACH
HERMOSA BEACH
REDONDO BEACH
12.2
50
100
200
300 FATHOMS

VOLATILE SOLIDS, SEDIMENT TRAP
HIGH = 42.3%
LOW = 6.9%


Pacific Palisades
SANTA MONICA
Mar Vista
Palms
Culver City
Venice
Playa Del Rey
Westchester
Los Angeles International Airport
EL SEGUNDO
MANHATTAN BEACH
HERMOSA BEACH
REDONDO BEACH
50
100
200
300 FATHOMS

VOLATILE SOLIDS, CORE
HIGH = 34.7%
LOW = 0.1%

198P-246

Figure III-B-18. Volatile solids by percent in suspended sediments (upper figure) and in bottom sediments (lower figure) in the vicinity of the HTP 7-mile outfall. Locations at which samples were taken are shown by a +. The isopleths are computer-drawn at the 25, 50, and 75 percentile concentrations for each data set, and intensity of color is indicative of concentration. The highest and lowest values from each data set are indicated on the figures. The highest value was from the station at the end of the 7-mile pipe (SCCWRP, unpublished data).

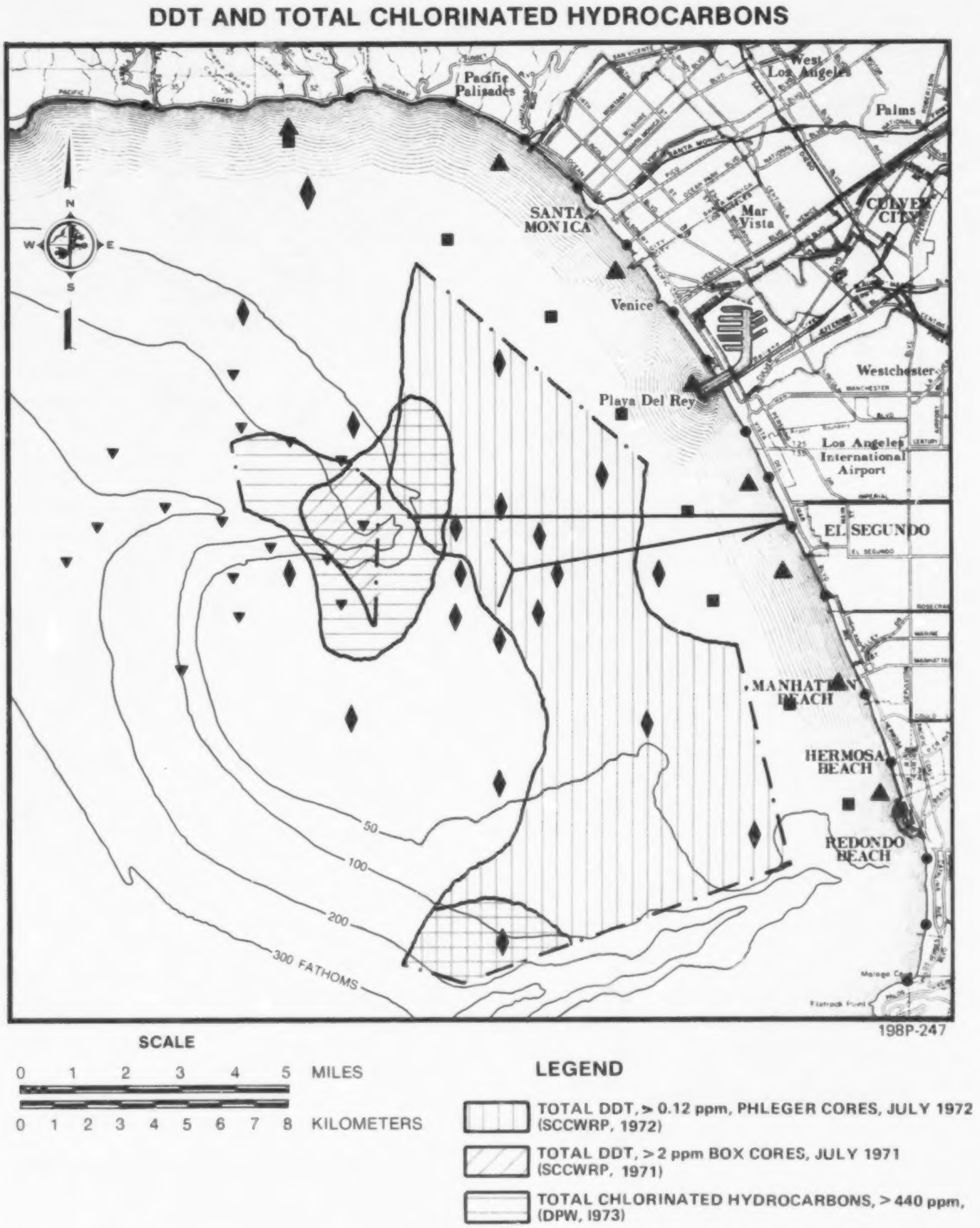
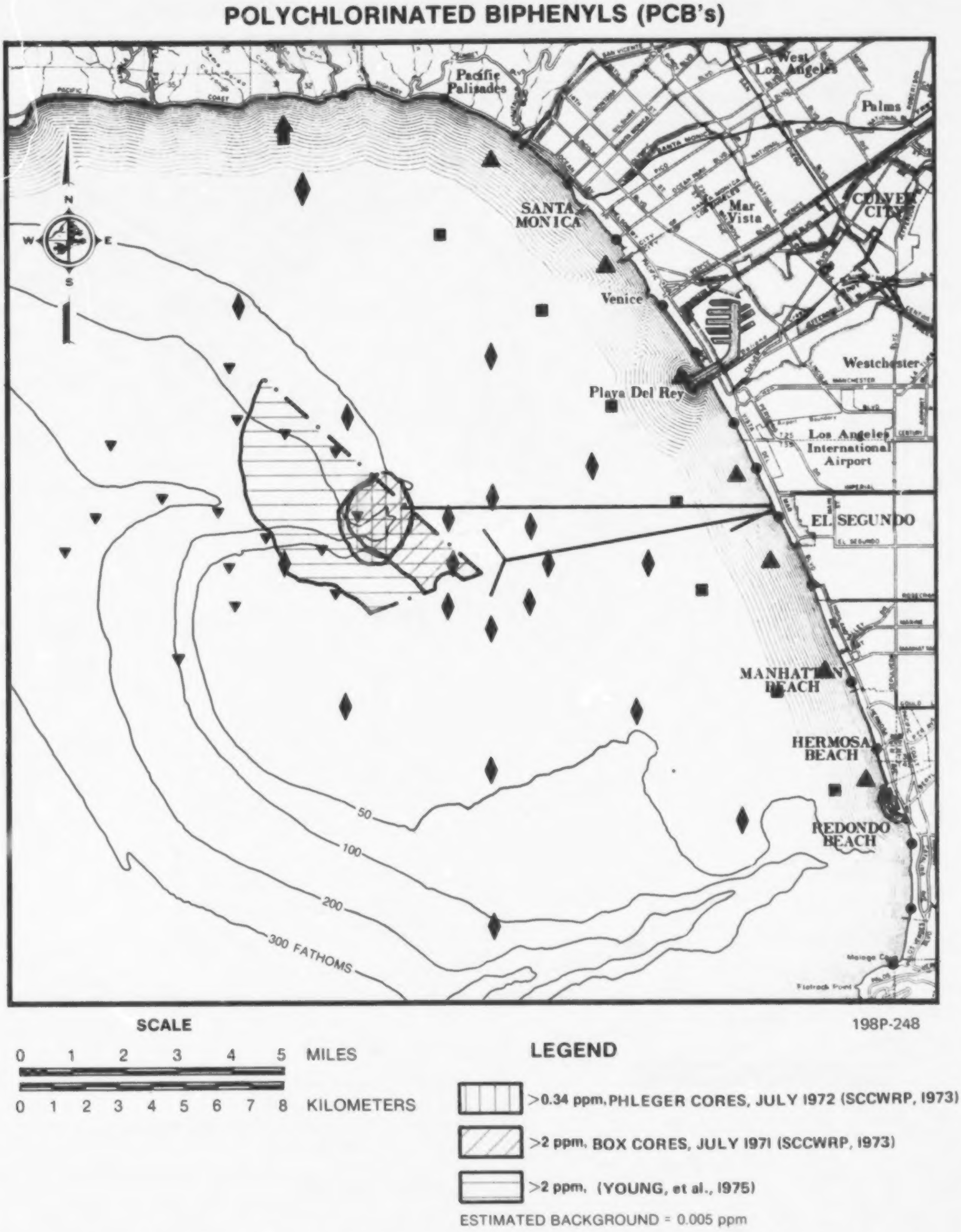

DDT AND TOTAL CHLORINATED HYDROCARBONS
Pacific Palisades
West Los Angeles
Palms
SANTA MONICA
Mar Vista
CULVER CITY
Venice
Westchester
Playa Del Rey
Los Angeles International Airport
EL SEGUNDO
MANHATTAN BEACH
HERMOSA BEACH
REDONDO BEACH
Malaga Cove
Flatrock Point
N
S
W
E
50
100
200
300 FATHOMS
198P-247
SCALE
0 1 2 3 4 5 MILES
0 1 2 3 4 5 6 7 8 KILOMETERS
LEGEND
TOTAL DDT, > 0.12 ppm, PHLEGER CORES, JULY 1972 (SCCWRP, 1972)
TOTAL DDT, > 2 ppm BOX CORES, JULY 1971 (SCCWRP, 1971)
TOTAL CHLORINATED HYDROCARBONS, > 440 ppm, (DPW, 1973)

Figure III-B-19. The solid lines are computer-drawn isoconcentration (in mg/dry kg) lines in the sediments in the vicinity of the HTP outfalls. The broken lines indicate a constraint imposed on the area included within the isopleths to keep the computer from extrapolating more than 1 or 2 km away from the nearest data point. The complete tabulated data and isopleth plots from which this figure was condensed are included in Appendix III.A (data from SCCWRP, 1973; DPW, 1973).


POLYCHLORINATED BIPHENYLS (PCB's)

Pacific Palisades
West Los Angeles
Palms
SANTA MONICA
Mar Vista
CULVER CITY
Venice
Westchester
Playa Del Rey
Los Angeles International Airport
EL SEGUNDO
MANHATTAN BEACH
HERMOSA BEACH
REDONDO BEACH
N
S
E
W
50
100
200
300 FATHOMS
SCALE
0 1 2 3 4 5 MILES
0 1 2 3 4 5 6 7 8 KILOMETERS
198P-248
LEGEND
>0.34 ppm. PHLEGER CORES, JULY 1972 (SCCWRP, 1973)
>2 ppm. BOX CORES, JULY 1971 (SCCWRP, 1973)
>2 ppm. (YOUNG, et al., 1975)
ESTIMATED BACKGROUND = 0.005 ppm

Figure III-B-20. The solid lines are computer-drawn isoconcentration lines in the sediments in the vicinity of the HTP outfalls. The broken lines indicate a constraint imposed on the area included within the isopleths to keep the computer from extrapolating more than 1 or 2 km away from the nearest data point. The complete tabulated data and isopleth plot from which this figure was condensed are included in Appendix III.A (data from SCCWRP, 1973; Young et al., 1975).

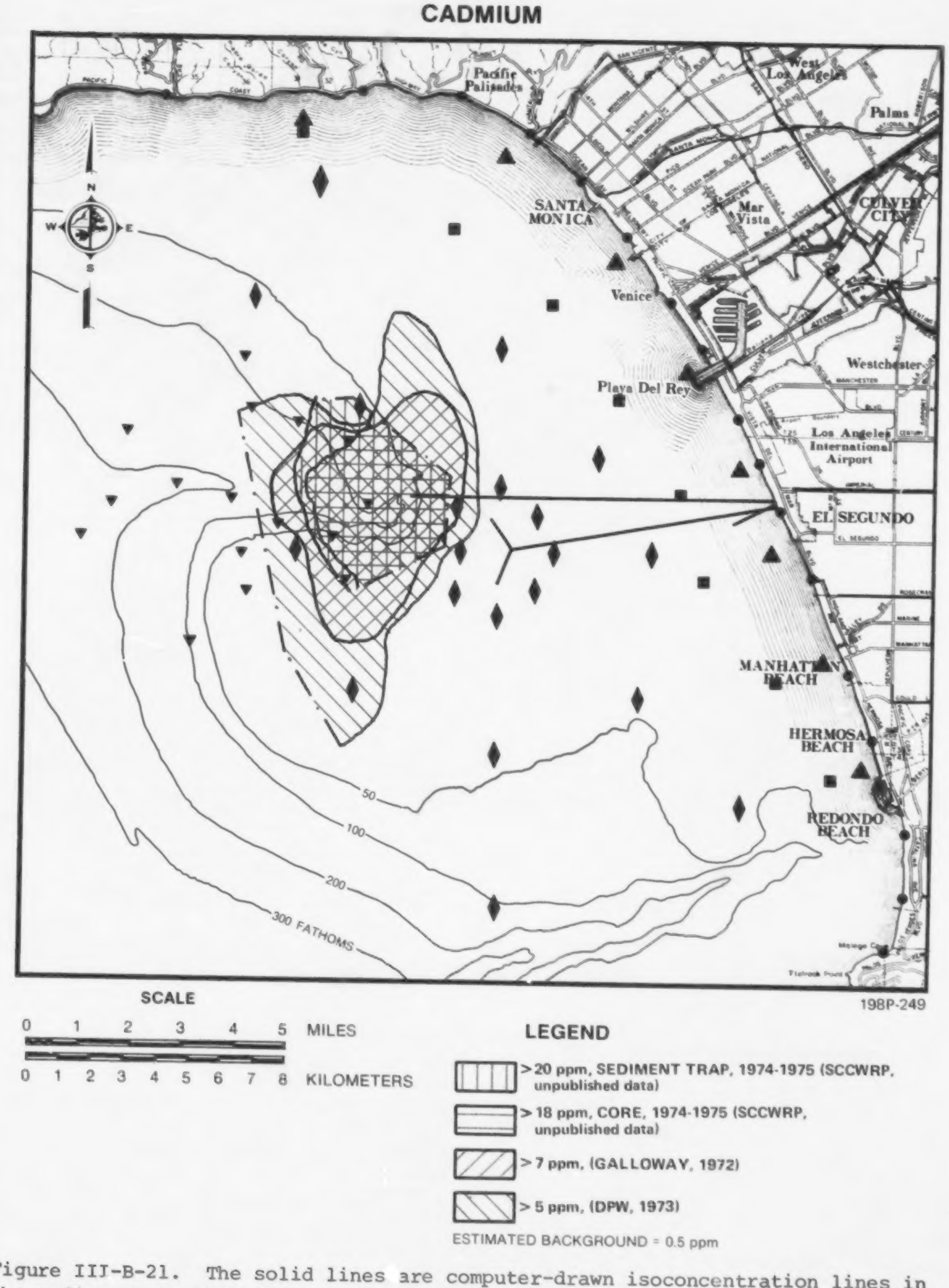
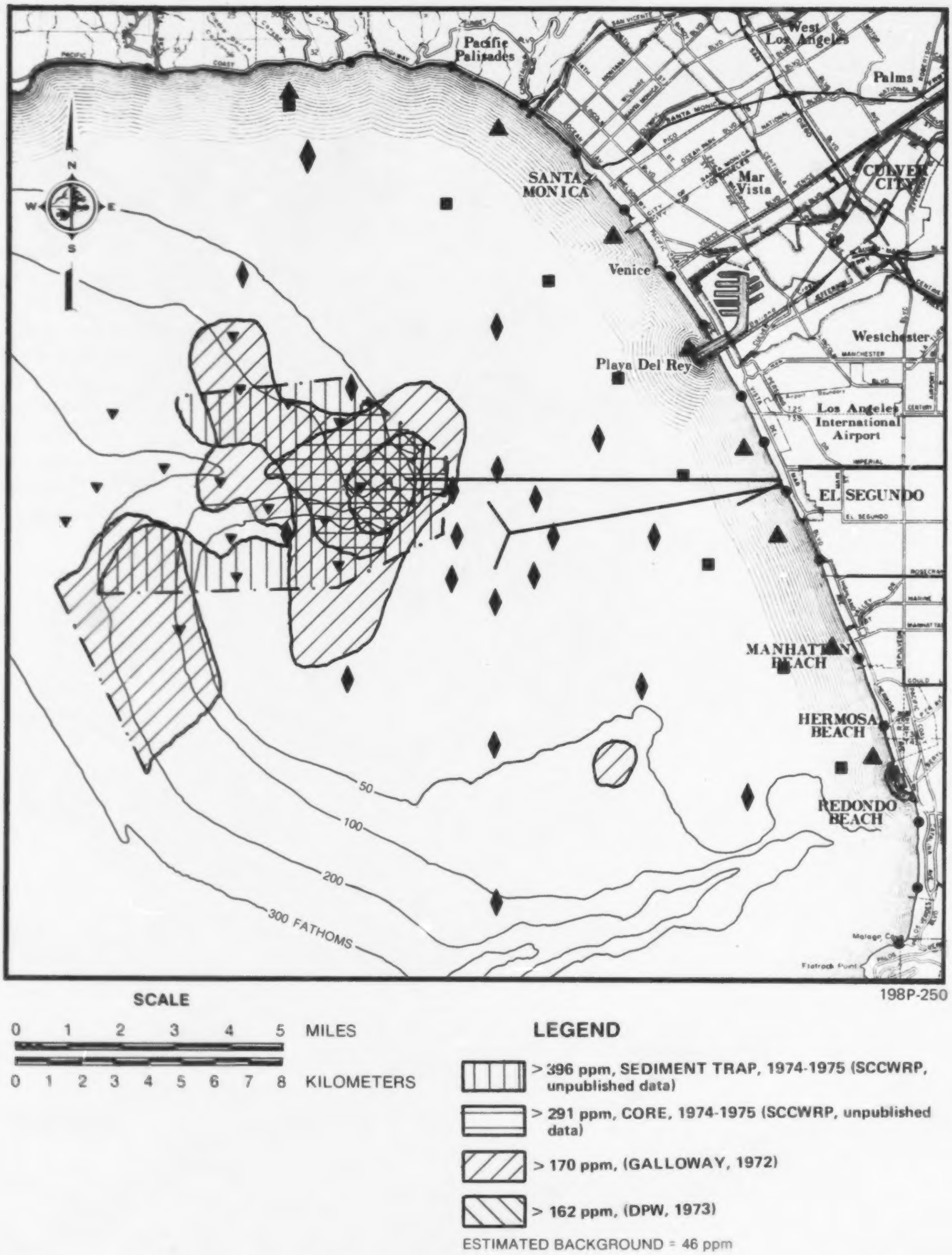

CADMIUM
Pacific Palisades
SANTA MONICA
West Los Angeles
Palms
Mar Vista
CULVER CITY
Venice
Westchester
Playa Del Rey
Los Angeles International Airport
EL SEGUNDO
MANHATTAN BEACH
HERMOSA BEACH
REDONDO BEACH
Malaga Cove
Flatrock Point
N
S
E
W
50
100
200
300 FATHOMS
198P-249
SCALE
0 1 2 3 4 5 MILES
0 1 2 3 4 5 6 7 8 KILOMETERS
LEGEND
>20 ppm, SEDIMENT TRAP, 1974-1975 (SCCWRP, unpublished data)
>18 ppm, CORE, 1974-1975 (SCCWRP, unpublished data)
>7 ppm, (GALLOWAY, 1972)
>5 ppm, (DPW, 1973)
ESTIMATED BACKGROUND = 0.5 ppm

Figure III-B-21. The solid lines are computer-drawn isoconcentration lines in the sediments in the vicinity of the HTP outfalls. The broken lines indicate a constraint imposed on the area included within the isopleths to keep the computer from extrapolating more than 1 or 2 km away from the nearest data point. The complete tabulated data and isopleth plot from which this figure was condensed are included in Appendix III.A (data from DPW, 1973; Galloway, 1972; SCCWRP, unpublished).



CHROMIUM

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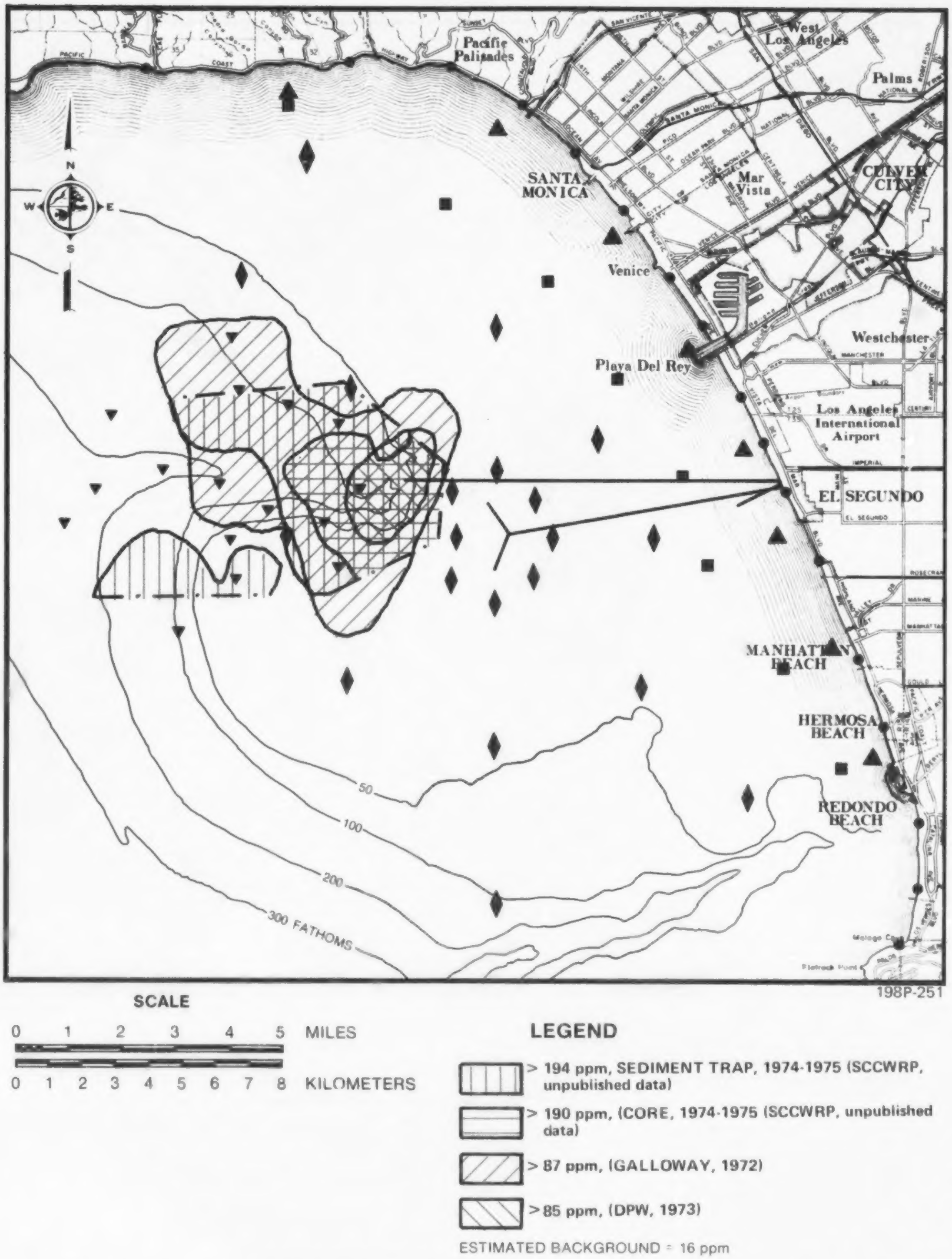
198P-250
SCALE
0 1 2 3 4 5 MILES
0 1 2 3 4 5 6 7 8 KILOMETERS
LEGEND
> 396 ppm, SEDIMENT TRAP, 1974-1975 (SCCWRP, unpublished data)
> 291 ppm, CORE, 1974-1975 (SCCWRP, unpublished data)
> 170 ppm, (GALLOWAY, 1972)
> 162 ppm, (DPW, 1973)
ESTIMATED BACKGROUND = 46 ppm

Figure III-B-22. The solid lines are computer-drawn isoconcentration lines in the sediments in the vicinity of the HTP outfalls. The broken lines indicate a constraint imposed on the area included within the isopleths to keep the computer from extrapolating more than 1 or 2 km away from the nearest data point. The complete tabulated data and isopleth plot from which this figure was condensed are included in Appendix III.A (data from DPW, 1973; Galloway, 1972; SCCWRP, unpublished).

COPPER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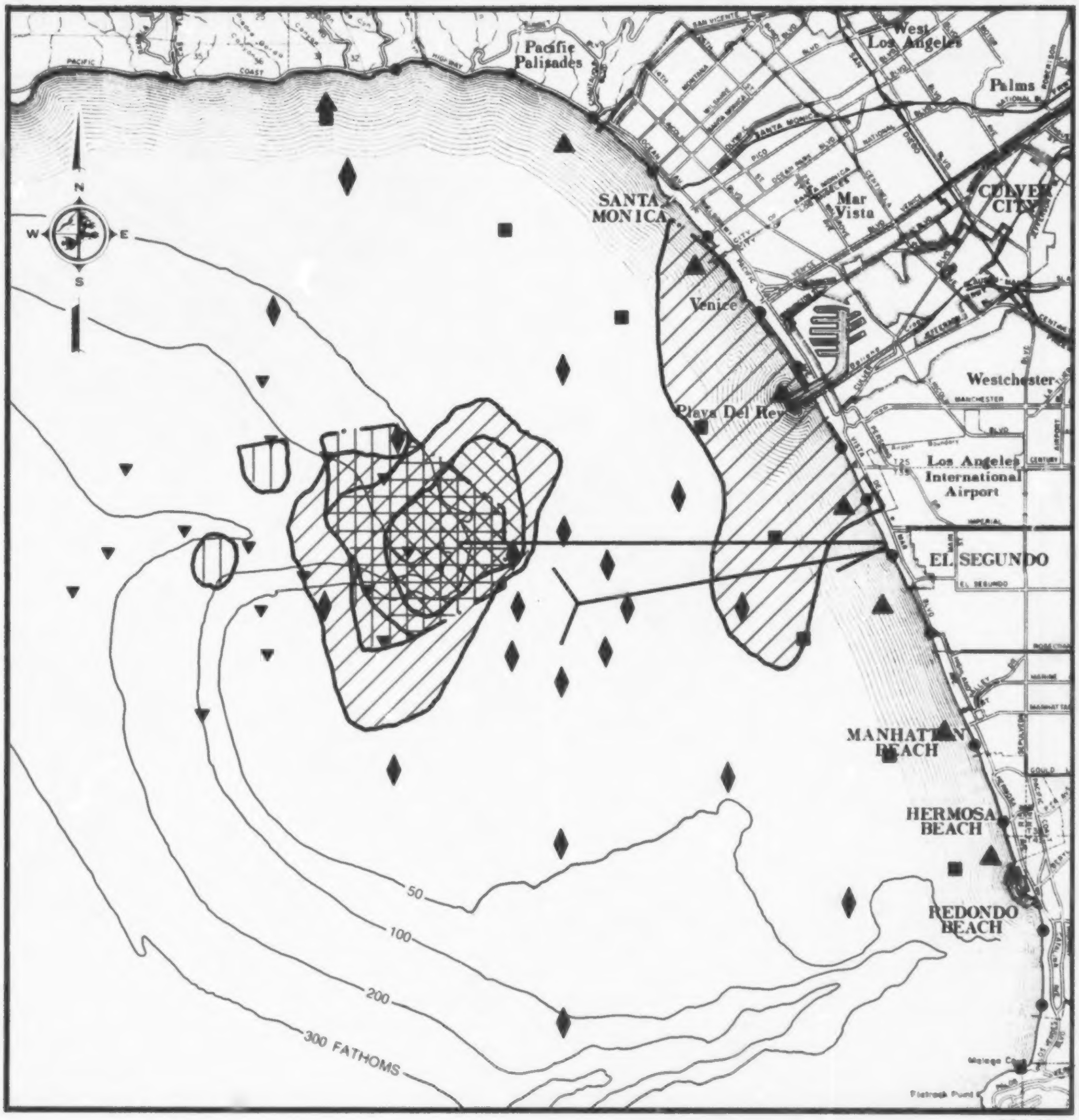
198P-251
SCALE
0 1 2 3 4 5 MILES
0 1 2 3 4 5 6 7 8 KILOMETERS
LEGEND
> 194 ppm, SEDIMENT TRAP, 1974-1975 (SCCWRP, unpublished data)
> 190 ppm, (CORE, 1974-1975 (SCCWRP, unpublished data)
> 87 ppm, (GALLOWAY, 1972)
> 85 ppm, (DPW, 1973)
ESTIMATED BACKGROUND = 16 ppm

Figure III-B-23. The solid lines are computer-drawn isoconcentration lines in the sediments in the vicinity of the HTP outfalls. The broken lines indicate a constraint imposed on the area included within the isopleths to keep the computer from extrapolating more than 1 or 2 km away from the nearest data point. The complete tabulated data and isopleth plot from which this figure was condensed are included in Appendix III.A (data from DPW, 1973; Galloway, 1972; SCCWRP, unpublished).

LEAD



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HERMOSA BEACH
REDONDO BEACH
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300 FATHOMS
198P-252
SCALE
0 1 2 3 4 5 MILES
0 1 2 3 4 5 6 7 8 KILOMETERS

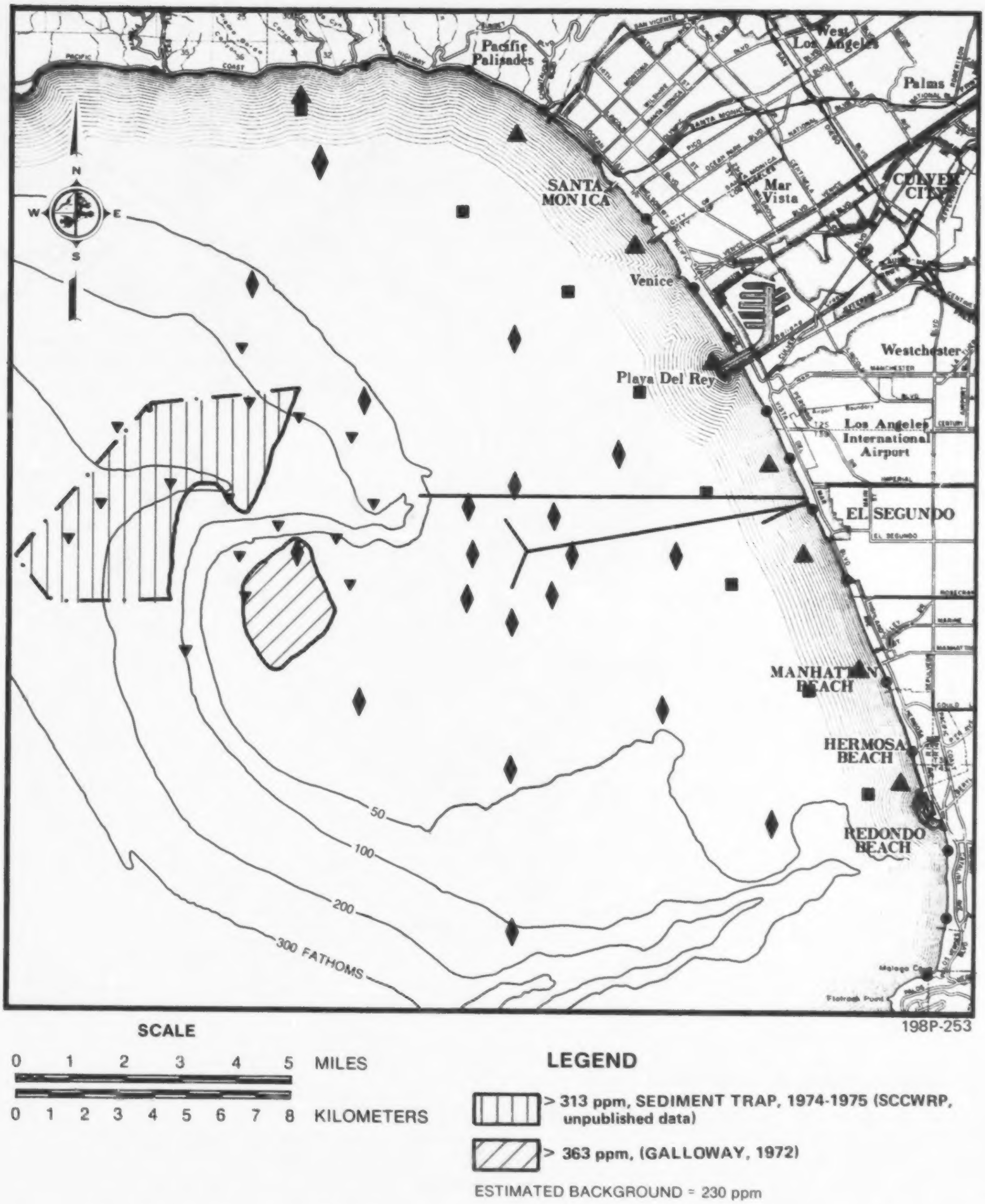
LEGEND

- ▥ >55 ppm, SEDIMENT TRAP, 1974-1975 (SCCWRP, unpublished data)
- ▤ >75 ppm, CORE 1974-1975 (SCCWRP, unpublished data)
- ▨ >40 ppm, (GALLOWAY, 1972)
- ▧ >21 ppm, (DPW, 1973)

ESTIMATED BACKGROUND = 9 ppm

Figure III-B-24. The solid lines are computer-drawn isoconcentration lines in the sediments in the vicinity of the HTP outfalls. The broken lines indicate a constraint imposed on the area included within the isopleths to keep the computer from extrapolating more than 1 or 2 km away from the nearest data point. The complete tabulated data and isopleth plot from which this figure was condensed are included in Appendix III.A (data from DPW, 1973; Galloway, 1972; SCCWRP, unpublished).

MANGANESE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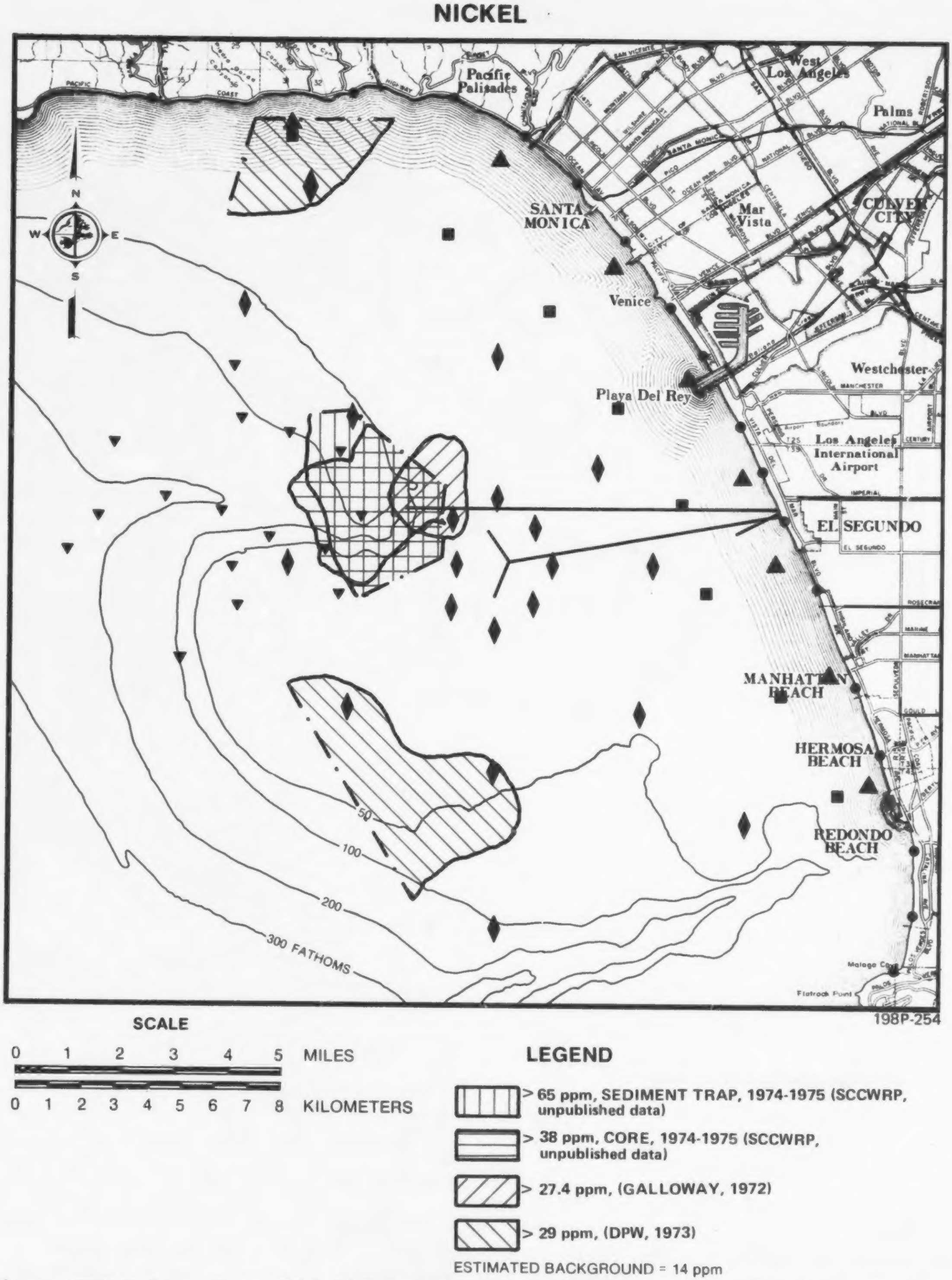
198P-253
SCALE
0 1 2 3 4 5 MILES
0 1 2 3 4 5 6 7 8 KILOMETERS
LEGEND
> 313 ppm, SEDIMENT TRAP, 1974-1975 (SCCWRP, unpublished data)
> 363 ppm, (GALLOWAY, 1972)
ESTIMATED BACKGROUND = 230 ppm

Figure III-B-25. The solid lines are computer-drawn isoconcentration lines in the sediments in the vicinity of the HTP outfalls. The broken lines indicate a constraint imposed on the area included within the isopleths to keep the computer from extrapolating more than 1 or 2 km away from the nearest data point. The complete tabulated data and isopleth plot from which this figure was condensed are included in Appendix III.A (data from Galloway, 1972; SCCWRP, unpublished).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HERMOSA BEACH
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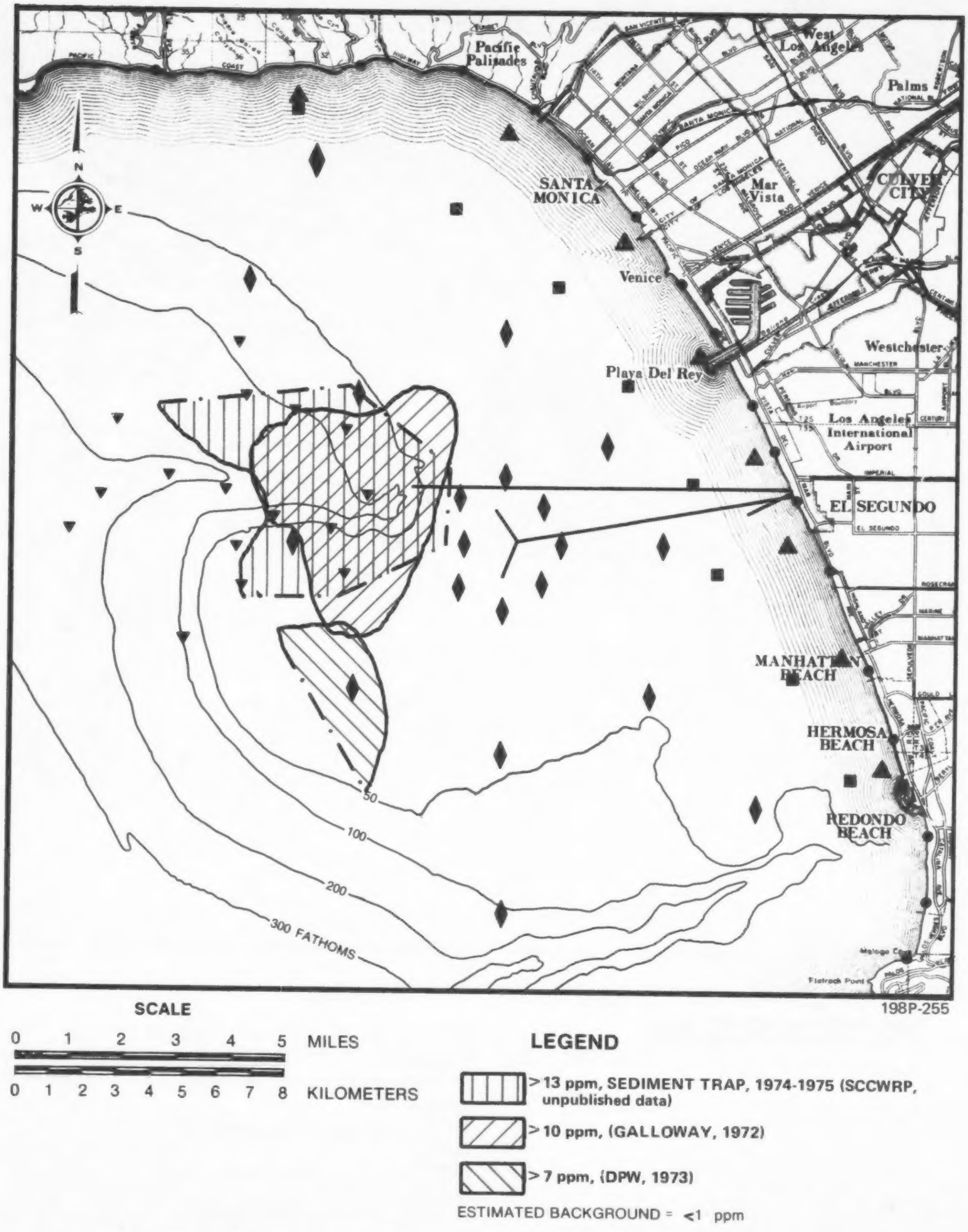
300 FATHOMS
198P-254
SCALE
0 1 2 3 4 5 MILES
0 1 2 3 4 5 6 7 8 KILOMETERS
LEGEND
> 65 ppm, SEDIMENT TRAP, 1974-1975 (SCCWRP, unpublished data)
> 38 ppm, CORE, 1974-1975 (SCCWRP, unpublished data)
> 27.4 ppm, (GALLOWAY, 1972)
> 29 ppm, (DPW, 1973)
ESTIMATED BACKGROUND = 14 ppm

Figure III-B-26. The solid lines are computer-drawn isoconcentration lines in the sediments in the vicinity of the HTP outfalls. The broken lines indicate a constraint imposed on the area included within the isopleths to keep the computer from extrapolating more than 1 or 2 km away from the nearest data point. The complete tabulated data and isopleth plot from which this figure was condensed are included in Appendix III.A (data from DPW, 1973; Galloway, 1972; SCCWRP, unpublished).

SILVER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REDONDO BEACH
Flatrock Point
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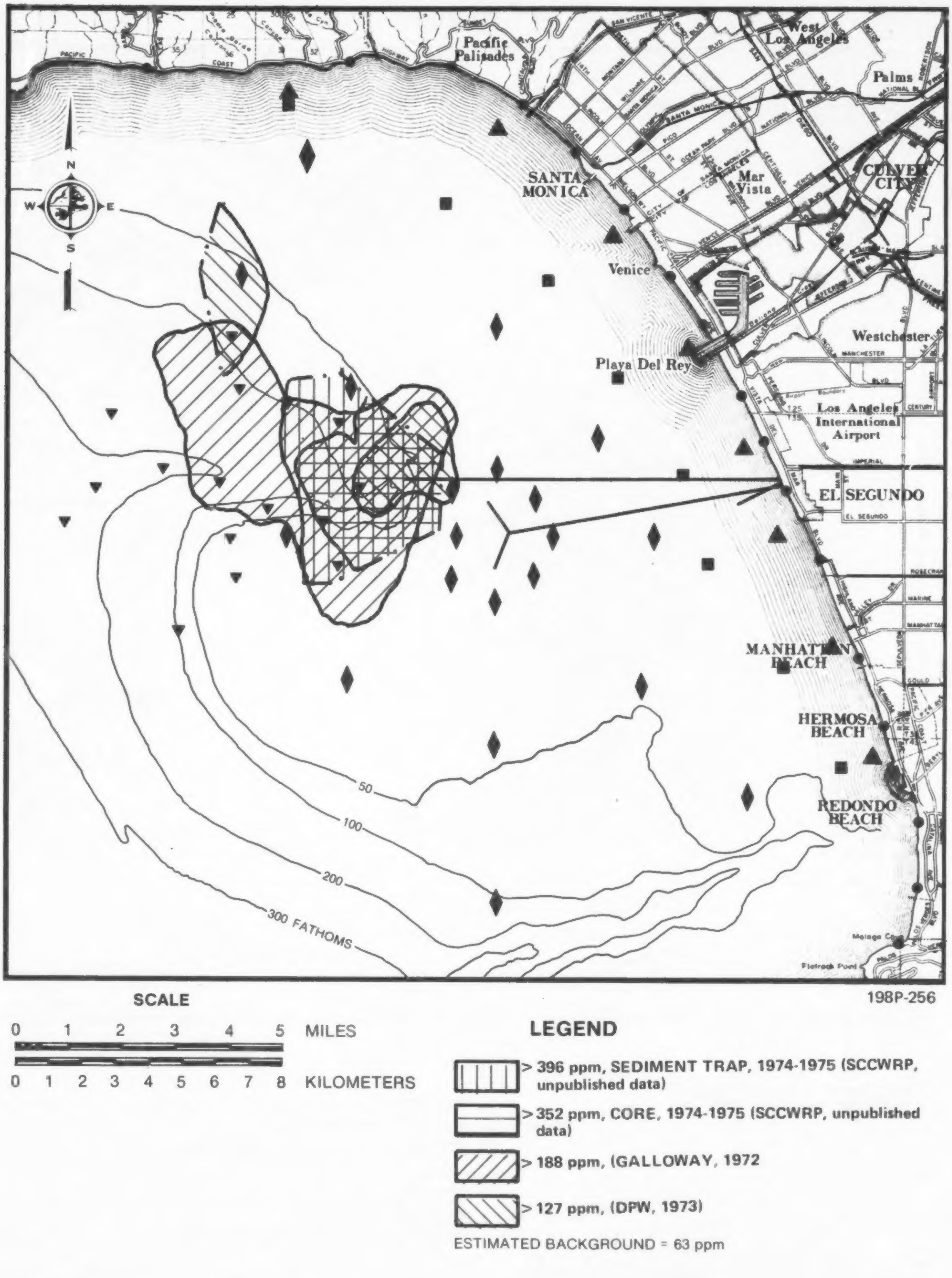
198P-255
SCALE
0 1 2 3 4 5 MILES
0 1 2 3 4 5 6 7 8 KILOMETERS
LEGEND
▥ > 13 ppm, SEDIMENT TRAP, 1974-1975 (SCCWRP, unpublished data)
▨ > 10 ppm, (GALLOWAY, 1972)
▧ > 7 ppm, (DPW, 1973)
ESTIMATED BACKGROUND = <1 ppm

Figure III-B-27. The solid lines are computer-drawn isoconcentration lines in the sediments in the vicinity of the HTP outfalls. The broken lines indicate a constraint imposed on the area included within the isopleths to keep the computer from extrapolating more than 1 or 2 km away from the nearest data point. The complete tabulated data and isopleth plot from which this figure was condensed are included in Appendix III.A (data from DPW, 1973; Galloway, 1972; SCCWRP, unpublished).

ZINC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SCALE
0 1 2 3 4 5 MILES
0 1 2 3 4 5 6 7 8 KILOMETERS
198P-256
LEGEND
▥ > 396 ppm, SEDIMENT TRAP, 1974-1975 (SCCWRP, unpublished data)
☐ > 352 ppm, CORE, 1974-1975 (SCCWRP, unpublished data)
▨ > 188 ppm, (GALLOWAY, 1972
▧ > 127 ppm, (DPW, 1973)
ESTIMATED BACKGROUND = 63 ppm

Figure III-B-28. The solid lines are computer-drawn isoconcentration lines in the sediments in the vicinity of the HTP outfalls. The broken lines indicate a constraint imposed on the area included within the isopleths to keep the computer from extrapolating more than 1 or 2 km away from the nearest data point. The complete tabulated data and isopleth plot from which this figure was condensed are included in Appendix III.A (data from DPW, 1973; Galloway 1972; SCCWRP, unpublished).

point because of their low density and ease of suspension. Had they not been trapped, they might have remained suspended or become resuspended, ultimately being transported out of the vicinity and settling in much lower concentrations, or releasing their attached metals to the water. This explanation supports the possibility that sediments released from the 7-mile outfall are ultimately transported out of the vicinity of the outfall, even though they may settle there temporarily. It argues against the hypothesis that most of the particulates leaving the outfall settle nearby.

(c). Compatability of Data. Nearly all studies included sampling at one location near the end of the 7-mile outfall. From the 400 m grid data it is evident that the exact location of that sample is critical if absolute sediment concentrations are to be compared between studies. The highest sediment concentration in each study usually occurred at a station near the end of the 7-mile outfall.

Can isopleths from the 1970-71 (Galloway), 1972 (HTP), 1974-75 (SCCWRP cores), and 1976 (SCCWRP) be compared to tell whether or not the maximum sediment concentrations are changing, or whether or not the sludge deposit is changing in size? Not with much confidence. For sampling to show changes with time, it is essential that the sampling and analytical techniques used be comparable over time. Several aspects of sampling are critical in determining changes over time in the sediments in relationship to sludge discharge, and each must be thoroughly tested to assure comparability of the data. Different equipment and/or different methods of deploying the same equipment by various investigators must be cross-calibrated for comparison of results. Variations in location of sampling points between the various studies may also have greatly influenced comparability of the data. The bottom is not perfectly flat but has depressions and ridges of various sizes as a result of physical (e.g., currents) and biological (e.g., organism burrowing) activities. The depressions will tend to accumulate settling particles and their associated wastewater constituents while ridges will have lower amounts of this material. Thus, samples taken on the ridges will be quite different from those taken in the depressions. A fairly fine grid pattern and replicate sampling should alleviate this problem. However, if the sampling points are not close together and replicates are not taken, as has been the case in some of the past sampling, then it is necessary to have samples taken at exactly (2-3 m radius) the same location in order to follow changes over time. The speed and direction of currents can also influence the actual sampling location by moving the sampling divice horizontally as it descends from the surface. Thus, accurate surface location of sample sites may not result in accurate bottom location of sample sites from one sampling date to the next, a problem that increases with depth.

The analytical techniques of each study group should also be compared by testing subsamples of a single sample by several laboratories. Once the sampling and analytical techniques are shown to be comparable, samples from the various studies can be used to assess changes in the sediments within and between years.

Figure III-B-29 illustrates the problem. It shows the highest metal concentrations recorded in each of the four studies normalized to the 1974* sewage particulate concentrations. (Only metals for which data from all four studies were available are included.) All the samples were taken near the end of the 7-mile outfall. That the highest values differ appreciably between samples collected by each of the investigators could be a result of year to year variation in the maximum sediment or sewage particulate concentrations, but is more likely a result of variation in the analytical accuracy of the measurement techniques between investigators and between years, or from failure to sample the same spot near the end of the 7-mile outfall in the various programs (for the above mentioned reasons). Thus, there is neither an absolute nor a relative sediment concentration that establishes the comparability of the measurements from year to year. Even if the data were accepted as numerically comparable, the coarseness of the 1970-75 grids would preclude the level of precision needed for comparing the early results to the 1976 400 m grid.

(d). Significance of the Sediment Data. Do the data from these sampling programs accurately represent the distribution of metals and other sewage-derived compounds in the sediments? There are insufficient data to allow a conclusion. Each of the HTP (1972) sediment samples included between 2 and 4 replicate grabs. No indices of variance have been calculated for these, but the range of each sample is published in DPW (1973), and the ranges are frequently large enough to suggest that variance between subsamples may be as great as variation between sample means over much of the grid. Further analysis should be performed on these data. In none of the three SCCWRP studies (1974-75 sediment trap and sediment core and 1976 400 m grid grab samples) were either replicate samples or subsamples taken. There are substantial differences in absolute values between adjacent sampling points, particularly on the 400 m grid, which underscore the need for replicate samples. Because of the lack of replicates, none of the concentration gradients shown in the figures of this section should be considered firmly established.

(e). Accumulation of Sludge. What percentage of the sludge particulates released from the 7-mile outfall accumulate near the outfall? It is possible to estimate the mass of sewage particulates remaining in the vicinity of the outfall within limits, using the data available. Mitchell and Schafer (in SCCWRP, 1975a) have made a calculation based on data from the SCCWRP 1974-75 sediment traps. They estimate that approximately 40 percent of the volatile solids (organic material) released from the HTP 7-mile outfall is still in the sediments and that 70 percent of the metals discharged remain in the sediments.

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*This analysis could be refined by normalizing the samples from each year to that year's effluent particulate concentration.

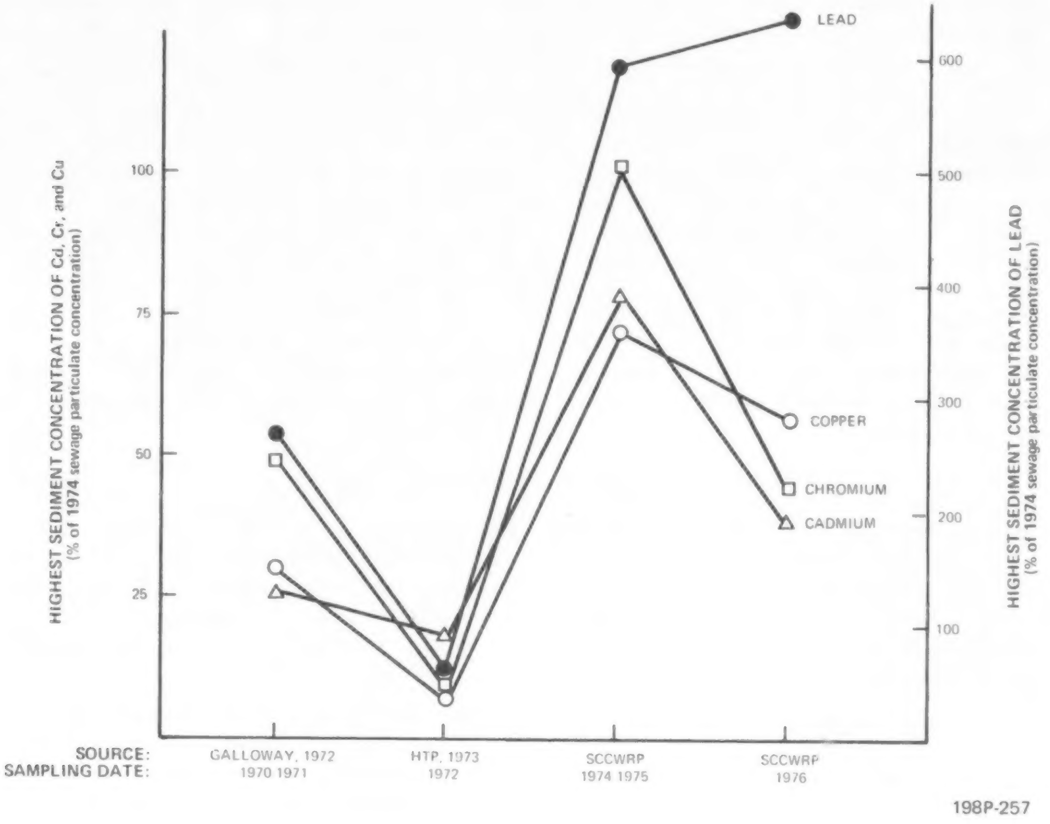


Figure III-B-29. Highest concentrations of copper, chromium, cadmium, and lead observed in four separate sediment studies near HTP outfalls expressed as percent of 1974 HTP sludge particulate concentrations. This figure shows that there are substantial differences in the maximum concentrations of metals sampled in the sediments between investigators and between years.

The following calculations, based on the more recent data from the 400 m sampling grid, tend to substantiate these results, although there remains considerable uncertainty in several of the parameters necessary for the calculations. The density, depth, and areal extent of the enriched sediments will have to be better delineated before the mass can be calculated with confidence. The isopleths of substance concentrations drawn on the 400 m grid (Figure III-B-14) are roughly equivalent to 25, 50, and 75 percent sewage-derived sediments. The area with the 25 percent isopleth is, for most substances, approximately 4 square km. If the average composition of the sediments within this isopleth is taken to be 62 percent sewage-derived sediments (half way between 25 and 100) and the average depth of these sediments to be 0.15 m, then the volume of sewage particulates in the sediments is equal to $(4\ km^2)(0.15\ m)(0.62) = 372{,}00\ m^3$. To compare this with the published mass emission values it must be converted to mass. The sediments are estimated to have a mass twice that of water or 2 metric tons/m^3, and the total accumulated sewage particulates (in the area enriched with at least 25 percent sewage sediments) is calculated to be 744,000 metric tons. The annual mass emission rate of settleable solids from the 7-mile outfall was 46,000 metric tons in 1974 (calculated from data in DPW, 1975a), and the outfall has been in operation for 15 years. It has thus released approximately 690,000 metric tons of settleable solids, a value similar to the 744,000 metric tons estimated to be present near the 7-mile outfall. This result independently reinforces the SCCWRP (1975a) conclusion that most of the particulates released through the 7-mile outfall since it began operation are still in the vicinity of the outfall.

Are toxic substances trapped in the sediments? The majority of the toxic metals (greater than 90 percent) in the Hyperion Treatment Plant 7-mile effluent are associated with particulates (SCCWRP, 1975a). Are these metals eventually trapped in the sediments as the particulates settle to the bottom? Or are they released into the water column where they become available for biological accumulation? Evidently, both processes occur depending on the size of the particulates and the length of time they are suspended prior to deposition.

The accumulation of toxicants in the sediments is influenced by physical, chemical, and biological processes which affect the settling rates as well as the release rates. Settling rate is dependent on the amount of the substances associated with various sized particulates, settling rates of these particulates, and releases to the water column before reaching the sediments (Chen and Lockwood, 1976). The size of particles with which a substance is associated is of importance since settling rate is dependent on particle size and density. If a particular substance is associated with large dense particles, then it will tend to become concentrated close to the outfall since these particles settle rapidly.

The release of trace metals from sludge particulates (from the anaerobic digesters) and suspended solids in the 5-mile effluent after dilution with seawater have been studied recently in the laboratory (Rohatgi and Chen, 1975). The release of metals from the sludge particulates after 5 weeks was highest for cadmium (96 percent) and nickel (64 percent); intermediate for manganese (36 percent), lead (35 percent), and zinc (39 percent); and lowest for copper (9 percent), chromium (4 percent), and iron (0 percent) (Table III-B-10). For the suspended solids in the 5-mile effluent, the release of metals was intermediate to high (38 to 93 percent) for all except chromium, iron, and manganese which were not released at all. The release of the metals may be attributable to oxidation of organic matter or metal sulfides, desorption from suspended solids (dependent on dilution and pH), and formation of metal chlorides as well as organo-metallic complexes (Rohatgi and Chen, 1975). In any case, the longer the sediments remain suspended, the lower the concentrations of metals that will be trapped in them.

Table III-B-10. Release of trace metals from digested sludge particulates and suspended solids in mixed primary and secondary effluent after dilution with seawater (Rohatgi & Chen, 1975).

METAL	SLUDGE			MIXED PRIMARY AND SECONDARY EFFLUENT		
	CONCENTRATION BEFORE DILUTION (mg/l)	INITIAL CONCENTRATION IN PARTICULATES (mg/kg)	PERCENT RELEASED AFTER 5 WEEK (1:200 DILUTION)	CONCENTRATION AFTER 5:1 DILUTION (μg/l)	INITIAL CONCENTRATION IN SUSPENDED SOLIDS (mg/kg)	PERCENT RELEASED AT EQUILIBRIUM
Cd	5.62	234	96.0	1.8	87.3	92.8
Cu	61.9	2,579	9.0	30	2,182	69.4
Cr	59.7	2,441	3.8	42.3	3,296	0
Fe	326	13,298	0	69.3	5,277	0
Mn	2.75	111	35.7	7.6	51.4	0
Ni	14.86	603	64.0	37.0	896	62.8
Pb	21.5	875	35.4	2.1	140.3	58.4
Zn	115.24	4,256	38.7	19.8	1,481	38.1

In another laboratory study (Faisst, 1976) the physical/chemical nature of sludge and the effects of mixing with seawater were determined for JWPCP and HTP sludges. Most of the particles were less than 10 μm in diameter, and more than 99 percent of all metals (Ag, Cd, Cr, Cu, Fe, Mn, Ni, Pb, and Zn) except Mn were attached to the particulates of the JWPCP sludge. Mixing of sludge with seawater in the presence of oxygen resulted in a less than 10 percent oxidation or solubilization of the solids, and Ni was the only metal mobilized to any extent. Settling rates measured were $\geq$ 0.01 cm/sec for 10 percent of the particulates and $\geq$ 0.0022 cm/sec for 20 percent of the solids in JWPCP sludge. Cr, Cu, and Zn were found to settle faster than the filterable solids while Ni and Pb settle more slowly.

Are metals mobilized from the sediments once they settle to the bottom? Evidence from a number of sources suggests that if mobilization occurs, it is a slow process. Morel et al. (1975) have made a strong case that once sediments are accumulated in the vicinity of the Whites Poin (JWPCP) outfall, no further mobilization takes place. Their primary evidence is the finding that the concentrations of cadmium, copper, chromium, zinc, and lead in the surface sediments all decrease rapidly with distance from the outfall, but that the concentrations of metals relative to one another (normalized to zinc) remain relatively constant. The applicability of these data to the HTP outfall is unknown, however, since the redox potential of the sediments near the JWPCP outfalls typically has been more negative than that near the HTP outfalls.

Considering the differential rate of release of metals from suspended sediments shown in Table III-B-10, the relative concentrations of metals would be expected to differ with the time the particulates were suspended, and would probably be related to distance from the outfall (Morel et al., 1975). Bascom (1975) has presented data showing a decrease in concentration of copper and cadmium in the surface sediments with distance from the Hyperion outfall, but the relative concentrations remain similar suggesting that metals are not being mobilized during settling near the outfall. Table III-B-11 compares the absolute concentrations of various sewage constituents in the wastewater (5-mile effluent and sludge) particulates with the maximum concentrations that have been measured from sediment collected from the ocean floor near the HTP outfalls and with background values away from sewage outfalls on the ocean floor. It shows that maximum concentrations near the outfalls are much higher than the ocean background levels and are in some cases higher than the 1974 mean total effluent particulate levels (e.g., for chromium, lead, maganese, zinc) but are usually lower than the sewage particulate levels.

Using values derived from the Hyperion Treatment Plant 1975 annual report, the relative concentrations of metals in the sewage particulates can be calculated and compared with the relative concentration of metals in the sediments near the 7-mile outfall. If the concentrations of metals relative to one another are the same in the sediments as in the sewage particulates, then the hypothesis of dilution by lithogenic (natural) sediments without mobilization is supported. Tables III-B-12 and 13 provide an analysis of metal concentrations (and percent volatile solids) in the sediments and sludge particulates. In Table III-B-12 metal concentrations have been normalized, by station, to the mean value of the combined copper and chromium concentration. The 12 monthly values for HTP (1975) were used to calculate the standard error for the concentration in sewage particulates, and the 26 sampling stations on the SCCWRP 1976 400 m grid were used to calculate the standard error for the sediment concentrations. The absolute values of copper and chromium were similar, and the two were pooled to give an analysis similar to that of Morel et al.

Table III-B-11. Concentrations of substances in 1974 HTP sewage particulates and in ocean sediments.

	CONCENTRATIONS IN SEWAGE PARTICULATES[1] (mg/dry kg)		HIGHEST CONCENTRATION[2] RECORDED IN OCEAN SEDIMENTS NEAR THE 7-MILE SLUDGE OUTFALL (mg/dry kg)	ESTIMATED OCEAN SEDIMENT BACKGROUND[3] (mg/dry kg)
	7-MILE	5-MILE		
Arsenic	25	120	8.6	--
Cadmium	172	238	134	0.5
Chromium	1,944	2,378	1,965	46
Copper	1,790	2,152	1,325	16
Iron	10,780	7,710	72,000	--
Lead	95	294	597	9
Manganese	26	241	410	230
Mercury	20.5	38.5	6.07	0.043
Nickel	408	2,082	340	14
Silver	55	240	57.6	0.71
Zinc	2,914	2,574	2,310	63
Phosphate	60,850	196,556	11,220	--
Nitrogen (total)	75,342	245,783	--	--
Cyanide	--	2,409	0.37	--
Phenol	--	723	1.3	--
Total Chlorinated Hydrocarbons	--	--	6,274	--
PCB	452	4,337	12	.005
DDT	559	8,675	2.0	.01
Volatile Solids (%)	59.23	73.1	34.7	2
COD	1,023,150	2,921,686	501,000	--
BOD	247,260	1,384,939	12,540	--

[1] These values were calculated by dividing the concentration of the substance in the effluent by the concentration of total solids in the effluent (all from Table III-B-2 multiplying the result by the percentage of the substance in the effluent known to be associated with the sludge particulate phase if that information was available in SCCWRP (1975a page 155). The values used are: Ca, 99% with particulate phase; Cr, 94%; Cu, 94%; Pb, 61%; Ni, 96%; Zn, 89%; Total phosphate phosphorus, 67%; BOD, 95%; COD, 97%; Volatile Solids, 92%. Otherwise, it was assumed that the substance was 100% in the particulates.

[2] From the data presented in Figures III-B-16 through 28.

[3] The concentration in the sediments well away from the outfall. The values in this column are estimates based on sediment values far from the outfalls, taken from the sediment studies presented in this report.

Table III-B-12. Test for significant differences in the concentrations (mg/dry kg) of metals in the sediments and in the sewage particulates. The resulting t-values (column 5) showed that when normalized to the mean concentration of copper plus chromium, chromium and lead were of significantly different concentrations in the sediment compared to the sludge particulates. The analysis is refined in Table III-B-13 where the significance disappears. Values in columns 1-4 are the mean ± standard error of the mean.

SUBSTANCE	1 CONCENTRATION IN SEWAGE PARTICULATES[1] (7-MILE EFFLUENT) (N=12)	2 CONCENTRATION IN BOTTOM SEDIMENTS (7-MILE OUTFALL) (N=26)	3 CONCENTRATION IN SEWAGE PARTICULATES NORMALIZED TO (Cr+Cr)/2 (N=12)	4 CONCENTRATION IN BOTTOM SEDIMENTS NORMALIZED TO (Cu+Cr)/2 (N=26)	5 t-VALUE (COLUMNS 3 & 4) *SIGNIFICANT AT 0.05 LEVEL **SIGNIFICANT AT 0.01 LEVEL
(Cu + Cr)/2	1,298 ± 147	264 ± 43	--	--	--
Copper	1,531 ± 139	299 ± 56	120.2 ± 4.9	104.3 ± 5.8	1.77
Cadmium	112 ± 10	21 ± 3	9.3 ± 1.0	8.2 ± 0.6	1.06
Chromium	1,064 ± 184	249 ± 37	79.8 ± 4.9	106.0 ± 8.5	2.11*
Nickel	285 ± 32	64 ± 11	24.4 ± 3.1	27.2 ± 2.5	0.69
Lead	121 ± 35	136 ± 27	10.0 ± 2.9	47.1 ± 2.8	8.27**
Volatile Solids (%)	58 ± 4	8.8 ± 1.4	4.9 ± 0.6	4.2 ± 0.6	0.76
Mercury	10.47 ± 1.13	1.69 ± 0.36	0.88 ± 0.1	0.7 ± 0.1	1.23
Silver	70.01 ± 21.38	10.65 ± 2.15	6.6 ± 1.7	7.6 ± 2.6	0.25

[1] Calculated by dividing the concentration of the substance in the 1975 HTP effluent by concentration of total solids in the effluent (for October, November, and December 1975 when data were available) or by the mean value of these 3 months (10,300 mg total solids/l) and multiplying times the fraction known to be associated with the sludge particulate fraction (from SCCWRP, 1975a: Cd = 0.99; Cr = 0.94; Cu = 0.94; Pb = 0.61; Ni =0.96; Volatile solids = 0.92). The fraction of Ag and Hg associated with the particulates is not presented and was assumed to be 100% (a potential source of error for these two variables).

(1975). Columns 3 and 4 were compared by constituent using a t test and 30 degrees of freedom. The t-value and its level of significance using a 2-tailed criterion is shown in column 5. Only lead and chromium are significantly different between the bottom sediments and the sewage particulates indicating that for all other constituents there is no detectable mobilization from the sediments. The analysis was then refined by standardizing the values of each constituent at each station by multiplying each value times the factor which was required to bring the mean of all values of that constituent to the mean value of copper.

The individual values thus standardized were then normalized by station to the mean value of all constituents at that station. Table III-B-13 shows the standardized values in columns 1 and 2, and the normalized values in columns 3 and 4. The normalized concentrations of each constituent in the bottom sediments (column 4) were then tested against the normalized concentrations in the sewage particulates. There were no significant differences between any two constituents supporting the no mobilization hypothesis. There is, however, additional evidence that some of the components of reduced sediments, particularly the organic carbon fraction (measured as volatile solids), may decrease with time. Figure III-B-30 shows that at stations from which core samples were taken, volatile solids decrease with depth much more rapidly than do other components. The core farthest from the outfall was intended to be a control core and to reflect background sediment concentrations. The declining concentration of metals with depth in the cores 2 and 6 km from the outfall may reflect lower metal mass emission rates or higher natural sedimentation rates at the time they were deposited. The apparent differential decreases between metals with depth, for example between cadmium and copper at the 2 km station, could be explained by either of these hypotheses, and more experimentation is required before it will be possible to distinguish between them.

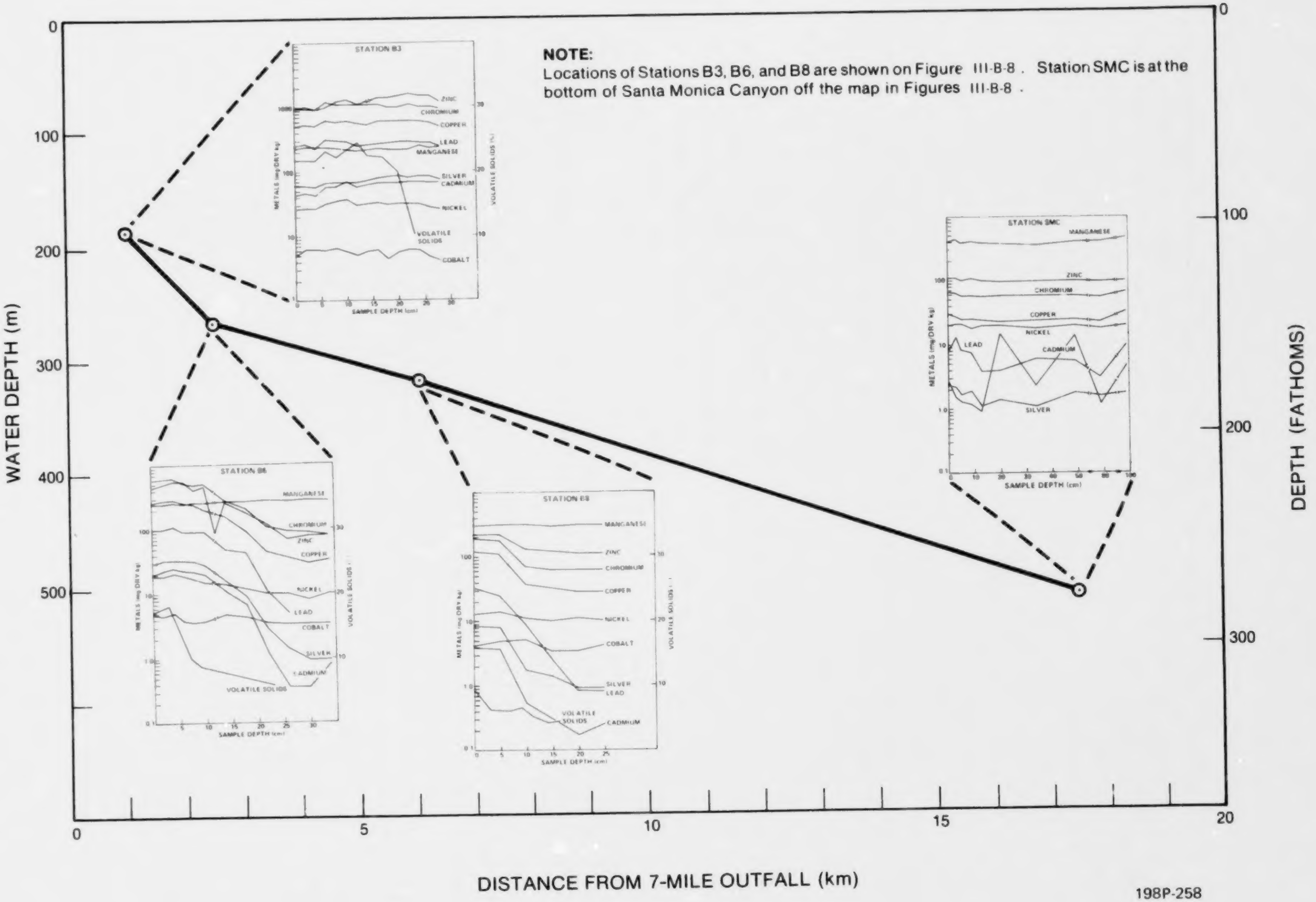
Accumulation of sludge may also be affected by currents or storm surges that can periodically resuspend and redistribute the particulates. Recent research has shown that the velocities necessary to resuspend sediments or initiate motion in sediments are substantially lower near wastewater outfalls (JWPCP and OCSD) than in non-outfall areas at the same depth (SCCWRP, 1976). The resuspension velocity was found to be nearly the same as the initiation of motion velocity near the outfalls, and the latter was inversely related to the percentage of volatile solids in the sediments. Furthermore, the resuspension velocity in the non-outfall area was considerably higher than that necessary to initiate motion. For the sediments around the Whites Point outfall, the resuspension velocity was approximately 6 cm/sec, and this velocity is exceeded during more than one third of the year. Thus, outfall-derived sediments of high organic content may be reworked or resuspended much more frequently than other sediments (SCCWRP, 1976). When this velocity is exceeded, the lighter organic particulates are likely to be dispersed over a much larger area than the heavier natural sediments.

Table III-B-13. Relative concentrations of metals and volatile solids in sewage effluent and bottom sediments near the HTP 7-mile outfall. Means ± standard error of the mean are shown. Sewage particulate concentrations are the mean of 12 months of HTP effluent data corrected by the factors shown in the footnote to Table III-B-12. Sediment concentrations are mean values at the 26 400 m grid stations shown in Figure III-B-12. The values in columns 1 and 2 are the values from columns 1 and 2 of Table III-B-12 standardized (see text). Columns 3 and 4 are the standardized values normalized at each month, or sampling station to the mean value of all constituents at their station. Using the t test with 30 degrees of freedom, there were no significant differences between any of the constituents in the sediments compared with those in the effluent, supporting the hypothesis of no mobilization.

SUBSTANCE	STANDARDIZED CONCENTRATION IN SEWAGE PARTICULATES (7-MI. OUTFALL)	STANDARDIZED CONCENTRATION IN BOTTOM SEDIMENTS (7-MI. OUTFALL)	STANDARDIZED CONCENTRATION IN SEWAGE PARTICULATES NORMALIZED TO Σ STANDARD CONCENTRATION	STANDARDIZED CONCENTRATION IN BOTTOM SEDIMENTS NORMALIZED TO Σ STANDARD CONCENTRATION	t VALUE
Copper	1,531 ± 139	299 ± 56	112.9 ± 6.8	89.3 ± 8.3	1.85
Cadmium	153 ± 137	298 ± 44	116.3 ± 10.6	97.4 ± 9.5	1.23
Chromium	1,489 ± 258	299 ± 44	110.8 ± 15.4	104.7 ± 10.9	0.33
Nickel	1,539 ± 173	301 ± 49	116.6 ± 12.0	98.4 ± 5.4	1.65
Lead	1,537 ± 441	299 ± 59	105.8 ± 24.7	87.0 ± 8.8	0.88
Volatile Solids (%)	1,529 ± 113	298 ± 47	115.4 ± 8.0	99.2 ± 7.3	1.38
Mercury	1,526 ± 165.13	299 ± 64	118.4 ± 13.7	96.7 ± 14.2	0.97
Silver	1,544 ± 423.43	300 ± 61	111.8 ± 26.1	115.0 ± 24.1	0.08

The critical t value = 2.042 for 95% confidence level 2-tailed t test where

$n_1 = 12$, $n_2 = 26$, $\nu = n_1 + n_2 - 2$ df.



NOTE:
Locations of Stations B3, B6, and B8 are shown on Figure III-B-8. Station SMC is at the bottom of Santa Monica Canyon off the map in Figures III-B-8.

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Figure III-B-30. Distribution of metals and volatile solids with depth in the sediments at varying distances from the HTP 7-mile outfall (data from SCCWRP, 1973 and 1975a).

(7) SUMMARY OF CHEMICAL AND PHYSICAL INPUTS FROM HTP. Approximately 99 percent of the settleable particulates and their associated metals and organic toxicants released from the Hyperion Treatment Plant are discharged from the 7-mile outfall along with 1.4 percent of the total liquid effluent. The remaining 1 percent of the settleable solids are released suspended in 98.6 percent of the liquid effluent from the 5-mile outfall. Thus, it is obvious why there has been an accumulation of particulates in the sediments in the vicinity of the 7-mile outfall and very little or no accumulation in the vicinity of the 5-mile outfall.

Accurate mass balance analysis of the sediments around the 7-mile outfall are probably impossible without more sediment core data, but a preliminary calculation indicates that a substantial percentage of the settleable sediments released from the 7-mile outfall may still be in its vicinity. Conversely, data from sediment traps suggests that much of the particulate-associated metals may be transported out of the vicinity of the outfall.

In either case, it appears that once sewage particulates are incorporated into the sediments there may be little or no mobilization of most metals from them, although there may be a gradual mobilization of volatile solids (organics). The area around the 7-mile outfall in which sediments are composed of more than 25 percent sewage constituents is approximately 4 square kilometers. There is insufficient data to determine whether or not it is changing in size with time. The areas of highest concentration are seaward from the end of the outfall. Very few measurements have been taken shoreward from the outfall, but those that have support the hypothesis that the sediments do not accumulate shoreward of the end of the outfall.

Virtually nothing is known about the distribution and concentration of metals and other toxic substances dissolved in the effluent, eluted from the particulates by the sea water, or transported in the plume bound to fine particulates. The distribution of the plume has been monitored through concentration of coliform bacteria, a sensitive but inexact monitoring technique influenced by bacterial mortality as well as by dilution and by light transmission (turbidity indicator). The coliform data indicate that the plume can be very extensive (particularly in deeper waters of the Bay), reaches the surface often in the winter, and may occasionally reach the shore. Bacterial concentrations reaching the shore are low from a public health standpoint, but the concentrations of metals and organic toxicants of plume origin that may reach nearshore and intertidal organisms are not known. Preliminary results from the light transmission studies indicate that the plume moves to the northwest and southeast as well as inshore (tidal influence), and that it does not surface.

b. Terminal Island Treatment Plant. The Terminal Island Treatment Plant (TITP) discharge is not discussed in detail here because it is being examined in detail in a separate environmental report. At present the outfall extends 450 feet into the outer harbor from Terminal Island (DPW, 1975a). The effluent receives primary treatment with no chlorination (Ohara, March 4, 1977), and the sludge is land filled (DPW, 1974). Water within the harbor shows a net advective seaward flow because of wastewater discharges, flow from Dominguez Channel, and cooling water discharge from the Los Angeles Water and Power Plant (Engineering-Science, Inc., 1971).

Wastewater from TITP is 84 percent domestic and 16 percent industrial wastes. The industries currently discharging wastewater to TITP are petrochemical, fish processing, and ship building and repairing. Less than 10 percent of the total industrial wastewater produced in the harbor area goes to TITP with the remainder going to the Los Angeles Sanitation Districts, the City of Long Beach, and directly to the Inner and Outer Harbors. Oil field brines have been discharged but were terminated in 1976 (DPW, 1974). The average characteristics for the discharge are given in Tables III-B-2 and 3. Shock loadings (short-term, high level) of substances occasionally occur (DPW, 1974).

Mixing of the discharged wastewater plume with the harbor waters will be discussed in a separate environmental report. Since there is a net seaward flow within the harbor, flushing does occur which aids in mixing and removal of wastewater to the ocean.

3. INDUSTRIAL DISCHARGES

The industrial discharges to the Southern California Bight are mainly waste heat from electrical generating stations and oil brines from the petroleum industry. One nuclear and fourteen fossil-fueled power plants are located in the Bight (Figure III-B-31), eight of which are in the Los Angeles area. The plant operation characteristics, temperature differential, and cooling water volumes are listed in Table III-B-14. The other industrial discharges are located from Point Conception to Newport Bay. Table III-B-15 lists some of the coastal dischargers along with the type of waste discharged, waste flow rate, and discharge pipe length and depth. The annual mass emissions for measured constituents from industrial dischargers are less than 13 percent of the total discharged to the Bight.

The distribution of and flow from the dischargers in the San Pedro Bay area are listed in Table III-B-16. Sixty-four percent of the dischargers are located in the Inner Harbor area of the Los Angeles-Long Beach Harbor. The flow rates for each of six waste types (oil field brines, oil tanker and line ballast, refinery and petrochemical, metallic, fish cannery, and miscellaneous chemical) are shown in Table III-B-17 for each major discharge area in the Bay area. The oil field brines and refinery and petrochemical wastes account for 69 percent of the volume discharged. The average concentrations and annual mass emission rates of TSS, BOD, COD, oil and greases, ammonia nitrogen, and phenols are given in Table III-B-18 for each waste type, and the mass emission rates for each of the substances by area are shown in Table III-B-19.

Table III-B-14. Thermal discharges at power generating stations in the southern California coastal area as of 1970-1971[1] (SCCWRP, 1973).

STATION - LOCATION	PLANT OPERATION			NORMAL AVERAGE TEMPERATURE RISE, T (°C)	ESTIMATED[2] COOLING WATER FLOW, R	
	CAPACITY, MWe (mw)	LOAD FACTOR, F (%)	OVERALL EFFICIENCY, E (%)		MAXIMUM, $R_{maximum}$ (10^6 m^3/day)	ANNUAL, $R_{average}$ (10^8 m^3/day)
FOSSIL-FUEL						
L.A. Dept. of Water and Power						
Harbor, Wilmington	445	14	25	11	2.1	1.1
Haynes, Seal Beach	1,625	60	36	10.5	4.8	10.5
Scattergood, Playa del Rey	350	59	34	10	1.2	2.5
Subtotal	2,420				8.1	14.1
Southern California Edison Company						
Alamitos, Seal Beach	1,950	58	36	11	5.5	11.6
El Segundo, El Segundo	1,020	50	35	12	2.7	5.0
Huntington, Huntington Beach	990	65	35	12	2.8	6.5
Long Beach, Long Beach[3]	210	20	25	10.5	1.0	0.8
Mandalay, Oxnard	430	73	36	11	1.2	3.2
Redondo, Redondo Beach	1,600	52	33	11	5.1	9.8
Ormond, Ormond Beach	1,580	55	34	10.5	5.1	10.2
Subtotal	7,780				23.4	47.1
San Diego Gas and Electric Company						
Encino, Carlsbad	345	55	34	10.5	1.1	2.2
Silver Gate, San Diego Bay	234	55	34	7	1.1	2.2
South Bay, San Diego Bay	530	55	34	7	2.5	5.0
Station "B," San Diego Bay	95	55	34	7	0.5	0.9
Subtotal	1,205				5.2	10.3
Total, Fossil-Fuel Type	11,405				36.7	71.5
Weighted Mean[4]	---	55	34	10.5	---	---
NUCLEAR						
San Onofre, San Clemente	450	80	32	10	1.9	5.5
TOTAL	11,855				38.6	77.0

[1] Station operating data provided by power companies, except as noted in Note 3 below.

[2] Calculated from plant waste heat, capacity, efficiency, temperature differential and load factor.

[3] Estimated values for the year 1971.

[4] All mean values are weighted by plant capacities.

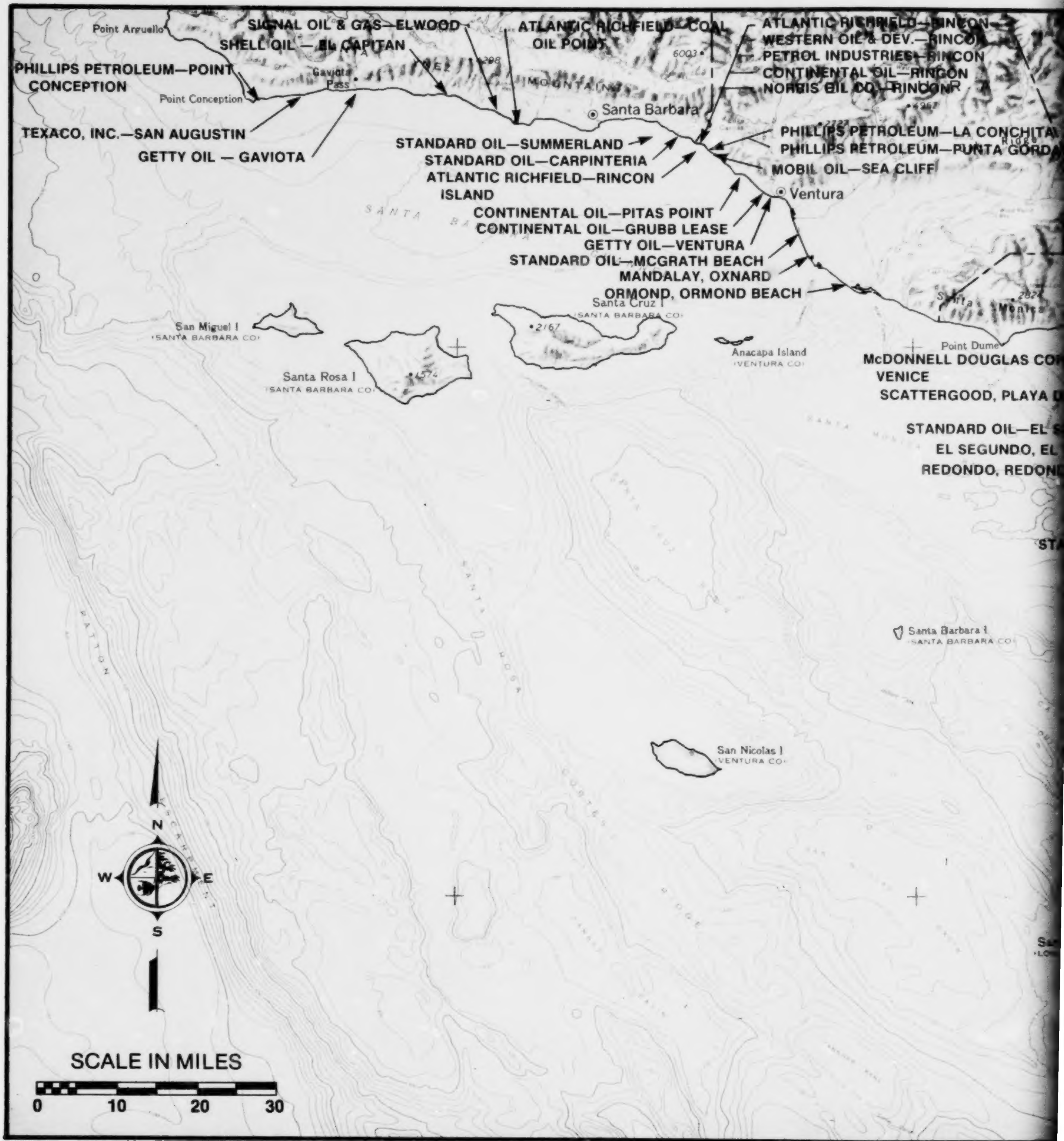
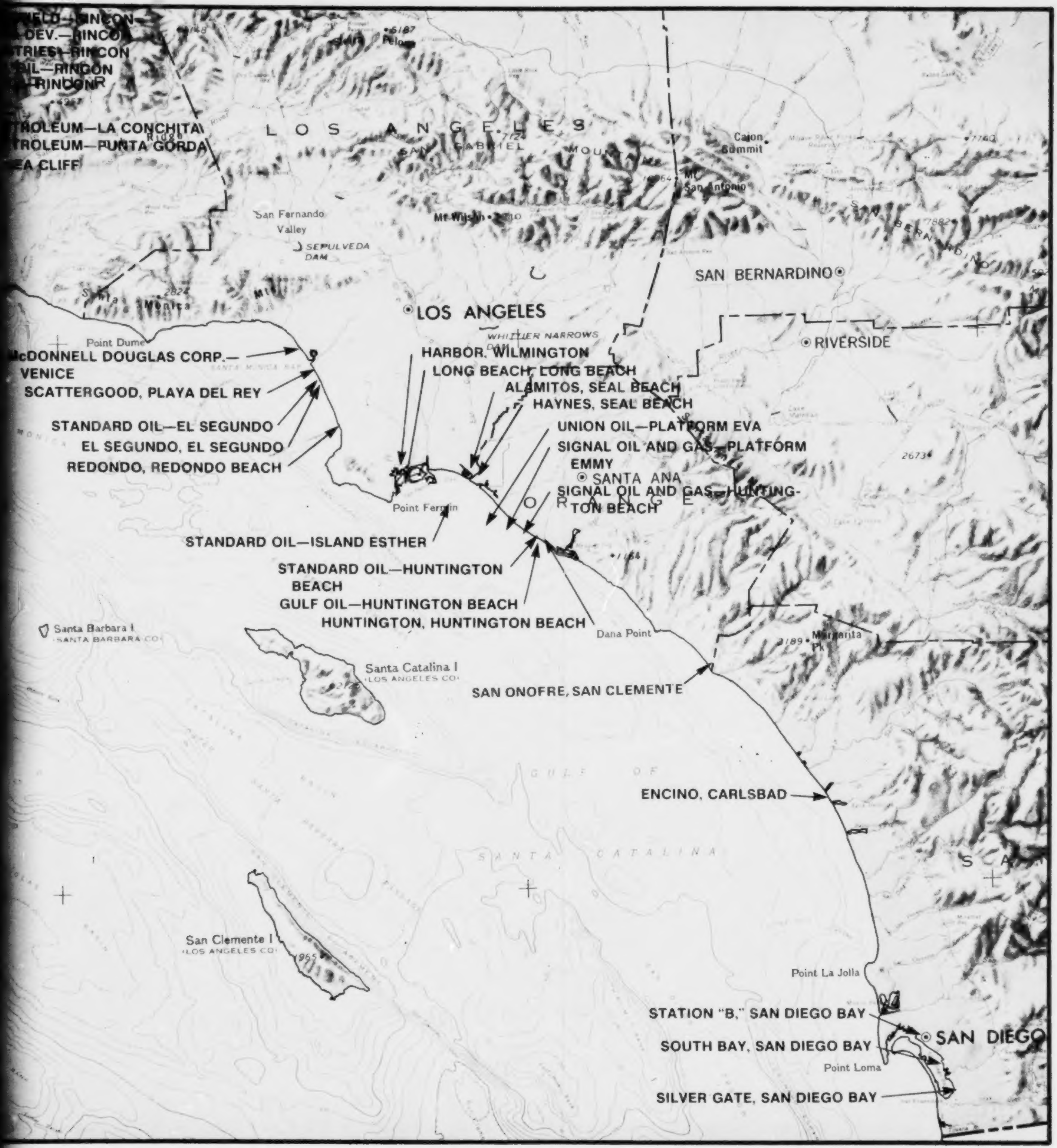

Point Arguello
SIGNAL OIL & GAS—ELWOOD
SHELL OIL — EL CAPITAN
ATLANTIC RICHFIELD—COAL OIL POINT
ATLANTIC RICHFIELD—RINCON
WESTERN OIL & DEV.—RINCON
PETROL INDUSTRIES—RINCON
CONTINENTAL OIL—RINCON
NORRIS OIL CO.—RINCON
PHILLIPS PETROLEUM—POINT CONCEPTION
Gaviota Pass
Point Conception
Santa Barbara
TEXACO, INC.—SAN AUGUSTIN
GETTY OIL — GAVIOTA
STANDARD OIL—SUMMERLAND
STANDARD OIL—CARPINTERIA
ATLANTIC RICHFIELD—RINCON ISLAND
PHILLIPS PETROLEUM—LA CONCHITA
PHILLIPS PETROLEUM—PUNTA GORDA
MOBIL OIL—SEA CLIFF
Ventura
CONTINENTAL OIL—PITAS POINT
CONTINENTAL OIL—GRUBB LEASE
GETTY OIL—VENTURA
STANDARD OIL—MCGRATH BEACH
MANDALAY, OXNARD
ORMOND, ORMOND BEACH
San Miguel I
SANTA BARBARA CO
Santa Rosa I
SANTA BARBARA CO
Santa Cruz I
SANTA BARBARA CO
Anacapa Island
VENTURA CO
Point Dume
McDONNELL DOUGLAS CO
VENICE
SCATTERGOOD, PLAYA D
STANDARD OIL—EL S
EL SEGUNDO, EL
REDONDO, REDON
ST
Santa Barbara I
SANTA BARBARA CO
San Nicolas I
VENTURA CO
PATTON ESCARPMENT
SANTA ROSA CORTES RIDGE
SANTA CRUZ
N
S
E
W
SCALE IN MILES
0
10
20
30

Figure III-B-31. Industrial waste and thermal discharges into the Southern California Bight. Depths are in fathoms (adapted from SCCWRP, 1973).

A


FIELD—RINCON
DEV.—RINCON
TRIES—RINCON
OIL—RINCON
—RINCON
TROLEUM—LA CONCHITA
TROLEUM—PUNTA GORDA
EA CLIFF
L O S   A N G E L E S
SAN GABRIEL MOUNTAINS
Cajon Summit
Mt San Antonio
San Fernando Valley
SEPULVEDA DAM
Mt Wilson
SAN BERNARDINO
Santa Monica Mts
LOS ANGELES
WHITTIER NARROWS DAM
RIVERSIDE
Point Dume
McDONNELL DOUGLAS CORP.—VENICE
SCATTERGOOD, PLAYA DEL REY
STANDARD OIL—EL SEGUNDO
EL SEGUNDO, EL SEGUNDO
REDONDO, REDONDO BEACH
HARBOR, WILMINGTON
LONG BEACH, LONG BEACH
ALAMITOS, SEAL BEACH
HAYNES, SEAL BEACH
UNION OIL—PLATFORM EVA
SIGNAL OIL AND GAS—PLATFORM EMMY
SANTA ANA
SIGNAL OIL AND GAS—HUNTINGTON BEACH
ORANGE
Point Fermin
STANDARD OIL—ISLAND ESTHER
STANDARD OIL—HUNTINGTON BEACH
GULF OIL—HUNTINGTON BEACH
HUNTINGTON, HUNTINGTON BEACH
Dana Point
Santa Barbara I
SANTA BARBARA CO
Santa Catalina I
LOS ANGELES CO
Margarita Pk
SAN ONOFRE, SAN CLEMENTE
GULF OF SANTA CATALINA
ENCINO, CARLSBAD
San Clemente I
LOS ANGELES CO
Point La Jolla
STATION "B," SAN DIEGO BAY
SAN DIEGO
SOUTH BAY, SAN DIEGO BAY
Point Loma
SILVER GATE, SAN DIEGO BAY

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B

Table III-B-15. Partial list of discrete industrial waste dischargers on the southern California coast exclusive of electrical generating stations (SCCWRP, 1973).

DISCHARGERS	TYPE OF WASTE	FLOW (mgd)	PIPE	
			LENGTH (m)	DEPTH (m)
Phillips Petroleum - Point Conception	Oil brine Tanker ballast	0.2		
Texaco, Inc. - San Augustin	Oil brine	0.2		
Getty Oil - Gaviota	Oil brine Tanker ballast	0.16		
Shell Oil - El Capitan	Oil brine Tanker ballast	0.2		
Signal Oil & Gas - Ellwood	Oil brine Tanker ballast	0.29		
Atlantic Richfield - Coal Oil Point	Oil brine	0.06		
Standard Oil - Summerland	Oil brine	0.4		32
Standard Oil - Carpinteria	Oil brine Tanker ballast	0.4	120	3
Atlantic Richfield - Rincon	Oil brine	0.01	76	6
Atlantic Richfield - Rincon Island	Oil brine	0.04	800	18
Western Oil & Dev. - Rincon	Oil brine	0.36		3
Petrol Industries - Rincon	Oil brine	0.01		
Continental Oil - Rincon	Oil brine	0.49	150	4
Norris Oil Co. - Rincon	Oil brine	0.05	670	3
Phillips Petroleum - La Conchita	Oil brine	0.36	270	6
Phillips Petroleum - Punta Gorda	Oil brine	0.4	150	6
Mobil Oil - Sea Cliff	Oil brine Tanker ballast	0.18	950	9
Continental Oil - Pitas Point	Oil brine	0.27	150	4
Continental Oil - Grubb Lease	Oil brine	0.75	150	2
Getty Oil - Ventura	Oil brine Tanker ballast	0.06		3
Standard Oil - McGrath Beach	Oil brine	0.14		1
McDonnell Douglas Corp. - Venice	Cooling tower bleedoff	0.65		
Standard Oil - El Segundo	Cooling water Refinery waste	72.0	170	5
Standard Oil - Island Esther	Oil brine	1.0		
Union Oil - Platform Eva	Oil brine	0.02		
Signal Oil and Gas - Platform Emmy	Oil brine	0.08		
Signal Oil and Gas - Huntington Beach	Oil brine	0.6	300	3
Standard Oil - Huntington Beach	Oil brine	0.8	310	4
Gulf Oil - Huntington Beach	Oil line ballast	0.01	300	

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Table III-B-16. Distribution of discrete industrial waste dischargers in the San Pedro Bay area (SCCWRP, 1973).

DISCHARGE AREA	NUMBER OF DISCHARGERS	COMBINED FLOW (mgd)
Los Angeles Harbor		
Outer Harbor	4	7.8
Fish Harbor	7	1.9
Main Channel	6	1.5
West Basin - Southwest Slip	15	29.2
East Basin - Slips 1 and 5	25	6.1
Consolidated Slip	34	0.25
Cerritos Channel	5	0.14
Subtotal	96	46.9
Long Beach Harbor		
Cerritos Channel	3	11.3
Channel Two	5	16.5
Channel Three	7	1.5
Southeast Basin	4	4.6
Subtotal	19	33.9
Dominguez Channel	23	10.3
Los Angeles River Tidal Prism	3	7.0
Los Cerritos Channel	7	0.2
San Gabriel River Tidal Prism	8	3.6
TOTAL	156	102

Table III-B-17. Combined flow rates of discrete industrial waste dischargers in San Pedro Bay area by type of waste (SCCWRP, 1973).

DISCHARGE AREA	FLOW RATE (MGD)						
	OIL FIELD BRINE	OIL TANKER AND LINE BALLAST	REFINERY AND PETROCHEMICAL	METALLIC	FISH CANNERY	MISCELLANEOUS CHEMICAL	TOTAL
Los Angeles Harbor	0.43	0.82	28.4	2.03	9.6	5.6	46.9
Long Beach Harbor	24.3	5.7	--	0.03	---	3.3	33.8
Dominguez Channel	0.05	--	6.5	1.4	---	2.3	10.3
Los Angeles River Tidal Prism	5.9	--	1.1	--	---	---	7.0
Los Cerritos Channel	---	--	--	0.12	---	0.04	0.2
San Gabriel River Tidal Prism	3.4	--	--	0.19	---	---	3.6
TOTAL	34.1	6.5	36.0	3.8	9.6	11.7	102

Table III-B-18. Average constituent concentration and annual mass emission rate for each type of industrial waste (excluding power plants) discharged to San Pedro Bay area (SCCWRP, 1973).

TYPE OF WASTE	FLOW RATE[1] (mgd)	TSS		BOD		COD		OIL AND GREASE		AMMONIA NITROGEN		PHENOLS	
		CONC. (mg/l)	MASS EMISSION (t/yr)[2]	CONC. (mg/l)	MASS EMISSION (t/yr)[2]	CONC. (mg/l)	MASS EMISSION (t/yr)[2]	CONC. (mg/l)	MASS EMISSION (t/yr)[2]	CONC. (mg/l)	MASS EMISSION (t/yr)[2]	CONC. (mg/l)	MASS EMISSION (t/yr)[2]
Oil Field Brine	8.5	18	210	110	1,285	410	4,789	6	70	200	2,336	0.3	3.5
Oil Tanker and Line Ballast	6.3	460	4,004	11	96	430	3,743	4	35	---[3]	---[3]	1.6	14
Refinery and Petrochemical	10.3	28	399	13	185	180	2,562	9	128	8	114	0.3	4.3
Metallic	1.6	44	97	7	16	150	332	6	13	21	46	0.01	0.02
Fish Cannery	2.0	---[3]	---[3]	---[3]	---[3]	---[3]	---[3]	32	88	---[3]	---[3]	--[3]	---[3]
Miscellaneous Chemical	5.3	16	117	1	7	50	366	1	7	---[3]	---[3]	--[3]	---[3]

[1] Combined flow rate of dischargers for which concentration data were available.

[2] Metric tons.

[3] No data.

Table III-B-19. Constituent mass emission rates (metric tons/year) from discrete industrial waste dischargers in the San Pedro Bay area (SCCWRP, 1973).

AREA	FLOW (mgd)	MASS EMISSION RATE (METRIC TONS/YEAR)					
		TOTAL SUSPENDED SOLIDS	5-DAY BIOCHEMICAL OXYGEN DEMAND	CHEMICAL OXYGEN DEMAND	OIL AND GREASE	AMMONIA NITROGEN	PHENOL
Los Angeles Harbor	46.9	1,880	620	8,300	370	120	14
Long Beach Harbor	33.8	9,900	3,800	17,600	230	6,800	22
Dominguez Channel	10.3	390	140	1,860	92	14	3
Los Angeles River Tidal Prism	7.0	190	910	3,600	59	1,640	3
Los Cerritos Channel	0.2	8	1	5	1	---	--
San Gabriel River Tidal Prism	3.6	96	510	1,920	28	940	1
TOTAL	102	12,500	5,980	33,300	780	9,510	43

4. OCEAN DUMPING

Substances disposed of by dumping in the ocean have in the past included refinery wastes, chemical wastes, filter cake, oil drilling wastes, refuse and garbage, radioactive wastes, military explosives, and miscellaneous other wastes (SCCWRP, 1973). Fourteen dumping sites have been designated since 1931; however, none of these are currently active (see Figure III-B-32). The quantity of each type of waste dumped, location, and time period are given in Table III-B-20. The estimated emission rate for these substances is shown in Table III-B-1. A brief description of each type of waste follows (taken from SCCWRP, 1973).

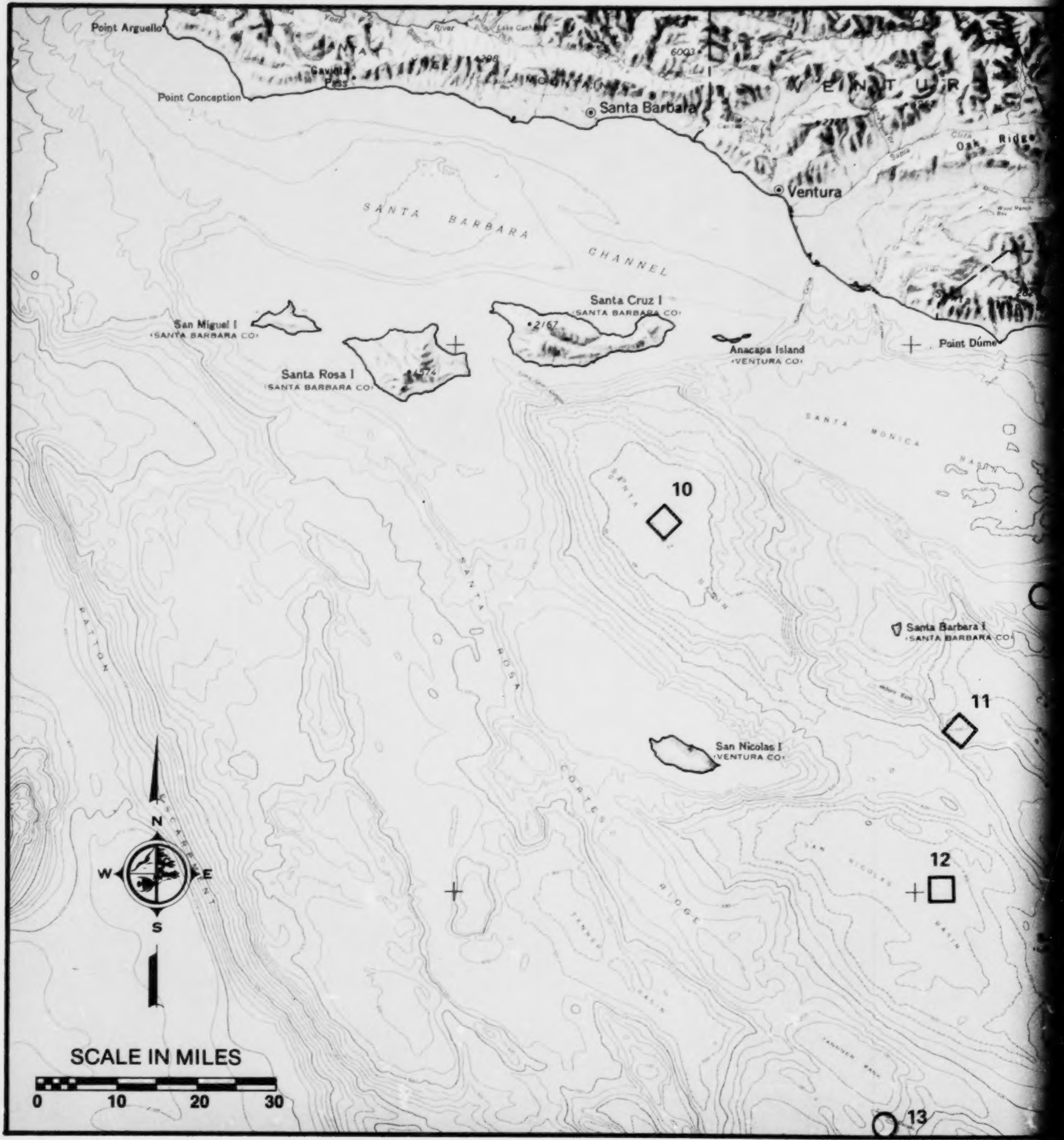
Refinery Wastes. The dumping of refinery wastes averaged 18,000 metric tons per year for the period 1946 to 1971; however, the rate decreased to 1,800 metric tons per year after 1968. The composition of these wastes is unknown but probably contains caustic solutions, acid sludges, spent catalysts, petrochemical wastes, and chemical cleaning wastes. They may also contain phenols, trace metals, trace organics, and other toxic materials.

Chemical Wastes. Chemical wastes are dumped in sealed containers. They include wastes from aerospace, heat-treating, plating, film processing, chemical processing, electronic manufacturing firms, laboratories (industrial, medical, and academic), military, and other sources. Sodium cyanide was dumped at Site 7 (Figure III-B-32) from 1960 to 1967 but has been prohibited since that time.

Filter Cake and Oil Drilling Wastes. Both of these are relatively inert substances. Filter cake, which is used in the extraction of algin from kelp, contains 70 percent fixed and 30 percent volatile solids, while oil drilling wastes are similar to dredge spoils. Dumping of both of these substances has been prohibited since 1970.

Refuse and Garbage. In the past, naval and commercial vessel refuse and garbage have been dumped in the ocean at designated sites. The naval vessel component has been terminated; however, approximately 1,200 metric tons per year for commercial vessels is still dumped at Site 4 (Figure III-B-32).

Miscellaneous Wastes. Military explosives and toxic chemical ammunition have been dumped at various sites during the period 1945 to 1970. Low level radioactive wastes were also dumped until prohibited in 1968.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Point Conception
Gaviota Pass
Santa Barbara
Ventura
Oak Ridge
SANTA BARBARA CHANNEL
San Miguel I
SANTA BARBARA CO
Santa Rosa I
SANTA BARBARA CO
Santa Cruz I
SANTA BARBARA CO
Anacapa Island
VENTURA CO
Point Dume
SANTA MONICA BASIN
SANTA CRUZ BASIN
10
Santa Barbara I
SANTA BARBARA CO
11
San Nicolas I
VENTURA CO
12
13
PATTON ESCARPMENT
SANTA ROSA CORTES RIDGE
TANNER BASIN
SAN NICOLAS BASIN
N
W
E
S
SCALE IN MILES
0
10
20
30

Figure III-B-32. Previously designated ocean dumping sites in the Southern California Bight. All are inactive now. Depths are in fathoms (SCCWRP, 1973).

A

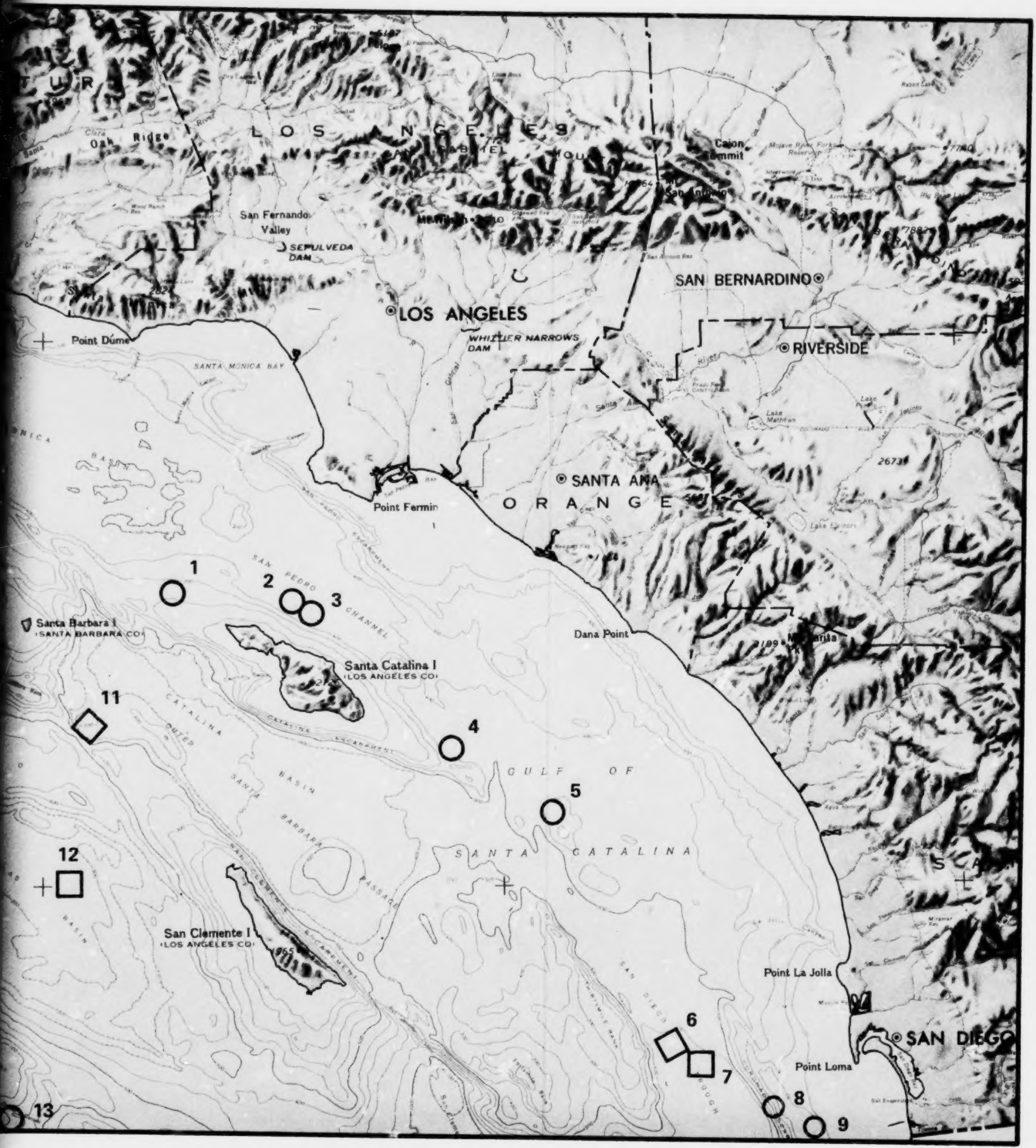
LOS ANGELES
San Fernando Valley
SEPULVEDA DAM
Oak Ridge
Cajon Summit
Mojave River Forks Reservoir
SAN BERNARDINO
LOS ANGELES
WHITTIER NARROWS DAM
RIVERSIDE
Point Dume
SANTA MONICA BAY
Lake Mathews
Lake Elsinore
2673
SANTA ANA
ORANGE
Point Fermin
SAN PEDRO CHANNEL
Dana Point
Santa Barbara I
(SANTA BARBARA CO)
Santa Catalina I
(LOS ANGELES CO)
CATALINA ESCARPMENT
OUTER SANTA BARBARA PASSAGE
CATALINA BASIN
GULF OF SANTA CATALINA
San Clemente I
(LOS ANGELES CO)
SAN CLEMENTE ESCARPMENT
SAN DIEGO TROUGH
Point La Jolla
SAN DIEGO
Point Loma
1
2
3
4
5
6
7
8
9
11
12
13

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Table III-B-20. Summary of wastes dumped into the Southern California Bight during 1931-1971 (SCCWRP, 1973).

TYPE OF WASTES	MAJOR DUMPING SITES[1]	PERIOD OF RECORD	ESTIMATED TOTAL DURING PERIOD OF RECORD (tons)[2]	ESTIMATED PRESENT TONNAGE[3] (tons/yr)[2]
Refinery Wastes	3	1946-71	480,000	1,800
Chemical Wastes	2, 3	1965-71	2,800	470
	4	1947-71	5,700	210
	7	1960-67	140	---
Filter Cake	8	1969-70	320,000	---
Oil Drilling Wastes	2	1966-70	3,000,000	---
Refuse and Garbage	4	1931-71	47,000	1,200
	5	1944-70	7,400	---
	9	1947-68	90,000	---
Radioactive Wastes	10, 14	1946-68		---
Military Explosives	6, 11, 12	1945-70		---
Miscellaneous Wastes				250

[1] See Figure III-B-32 for locations of dumping sites.

[2] Metric tons

[3] Wastes for which no present tonnage estimate is given have been discontinued (military explosives by moratorium).

Ocean dumping is regulated by the Marine Protection, Research, and Sanctuaries Act of 1972, Section 102. The only current EPA permit is to Shell Oil Company for drilling wastes at a site (LA-2) located outside the Los Angeles Harbor (Kremer, 29 April 1977).

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5. OCEANGOING VESSELS

Ocean vessels (naval, commercial, and recreational craft) contribute trace constituents to the marine environment through antifouling paints, zinc anodes, and fuels. Antifouling paints are used on vessel bottoms to help prevent marine organisms from growing on them, and the larger vessels also use primers that contain trace metals. The trace metals and PCB's typically found in these paints are listed in Table III-B-21. The estimated annual mass input of these substances into the Southern California Bight is presented in Table III-B-22. The total mercury input is higher than that from treated wastewaters and surface runoff (see Table III-B-1) while the inputs of the other constituents are less than those contributed by wastewater and surface runoff (SCCWRP, 1973). PCB use in antifouling paints, however, is being phased out (Kremer, 29 April 1977).

Table III-B-21. Typical constituent composition of antifouling paints and primers (SCCWRP, 1973).

TYPE	CONSTITUENT	AVERAGE CONCENTRATION (% BY WEIGHT)
Antifouling Paint	Copper	50
	Mercury	0.5[1]
	Arsenic	0.2[2]
	PCB	0.5[3]
Zinc Chromate Primer	Zinc	45
	Chromium	12
Red Lead Primer	Lead	25

[1] Assuming that mercury content of mercury paints is 5 percent and that mercury paints comprise 10 percent of total paint usage.

[2] Assuming that arsenic content of arsenic paints is 2 percent and that arsenic paints comprise 10 percent of total paint usage.

[3] Assuming that PCB content of paints is 5 percent and that paints containing PCB comprise 10 percent of total paint usage.

Table III-B-22. Trace constituent mass emission rates from recreational, commercial, and naval vessels to the Southern California Bight[1] (SCCWRP, 1973).

SOURCE	GROSS TONNAGE	MASS EMISSION RATES (metric tons/yr)							
		ARSENIC	CADMIUM	CHROMIUM	COPPER	MERCURY	LEAD	ZINC	PCB
Recreational Vessels									
Antifouling Paint	720	1.4	---	--	360	3.6	---	---	3.6
Zinc Anode	160	---	0.1	--	---	---	---	160	---
Fuel	---	---	---	--	---	---	3.5	---	---
Commercial and Naval Vessels[2]									
Antifouling Paint	52	0.1	---	--	26	0.3	---	---	0.3
Zinc Chromate Primer	8.2	---	---	1	---	---	---	4.1	0.1
Red Lead Primer	24	---	---	--	---	---	6	---	0.1
TOTAL		1.5	0.1	1	386	3.9	9.5	164	4.1

[1] Excludes ocean dumping contributions.

[2] No estimates for gross tonnage of zinc anodes and fuel used.

Zinc anodes are used on marine vessels to help prevent galvanic corrosion. Studies at Marina del Rey in Los Angeles have shown that approximately 90 percent of the recreational craft use anodes at a rate of 4 to 5 kg/yr (SCCWRP, 1973). Thus, projected to all recreational craft in the Bight, the estimated zinc addition to the marine environment from anodes is 160 metric tons per year and occurs mainly in marinas. In addition, 0.1 metric tons of cadmium are added along with the zinc. This estimate, however, is low since commercial and naval vessel inputs are unknown (SCCWRP, 1973).

Recreational craft use leaded gasoline which is a source of lead addition to the marine environment (low lead = 0.5 g Pb/gal and high octane = 3.0 g Pb/gal). Based on the Union Oil Company gas sales in Marina del Rey and the total number of recreational craft in Southern California marinas, the input of lead to the Bight would be approximately 3.5 metric tons per year (SCCWRP, 1973).

6. AERIAL FALLOUT

Aerial fallout consists of both dry fallout and rain washout. The annual mass transport to the Bight from rain washout has been calculated from data collected at Santa Catalina Island for the period September 1966 to January 1967 using an average of 40 cm of rain per year over a 100,000 km^2 area (SCCWRP, 1973). The concentration of metals in rain water are shown in Table III-B-23. The rate of lead, mercury, and manganese input is much greater than that from discrete sources while the rates for iron and nickel are much less and copper and zinc are about the same as from the discrete sources (Table III-B-1). Dry fallout rates may exceed those for rain washout in some cases. Studies on lead fallout at La Jolla (Chow and Earl, 1970) showed a rate of 24 $mg/m^2 \cdot yr$ resulting from leaded gasoline combustion. Extrapolation to the entire Bight results in 2,400 metric tons per year for dry fallout compared to 1,000 metric tons per year for rain washout (SCCWRP, 1973). A study of dry fallout of chlorinated hydrocarbons at La Jolla in February 1972 indicated a rate of 0.1 $\mu g/m^2 \cdot day$ containing approximately equal amounts of DDT and PCB. Extrapolation to the Bight shows an input of 2 metric tons of each per year which is lower than the rate of influx through municipal wastewater (SCCWRP, 1973). The average dry aerial fallout of total DDT at various locations in the Bight is shown in Figure III-B-33 for 1973 and 1974. Except for the Ensenada (Mexico) high value, the trend is for increasing fallout towards Los Angeles. Further studies in Los Angeles during 1974 (SCCWRP, 1975a) showed that the fallout was highest around the Montrose Chemical Company plant in Torrance ($11{,}483 \times 10^{-9} g/m^2 \cdot day$) and the sanitary landfill in Rolling Hills Estates ($3{,}485 \times 10^{-9} g/m^2 \cdot day$).

Table III-B-23. Trace metal concentrations in rainwater falling on the Southern California Bight (SCCWRP, 1973).

METAL	MEDIAN CONCENTRATION (μg/l)
Copper	10
Mercury	0.2
Nickel	1
Lead	25
Zinc	55
Iron	1
Manganese	12

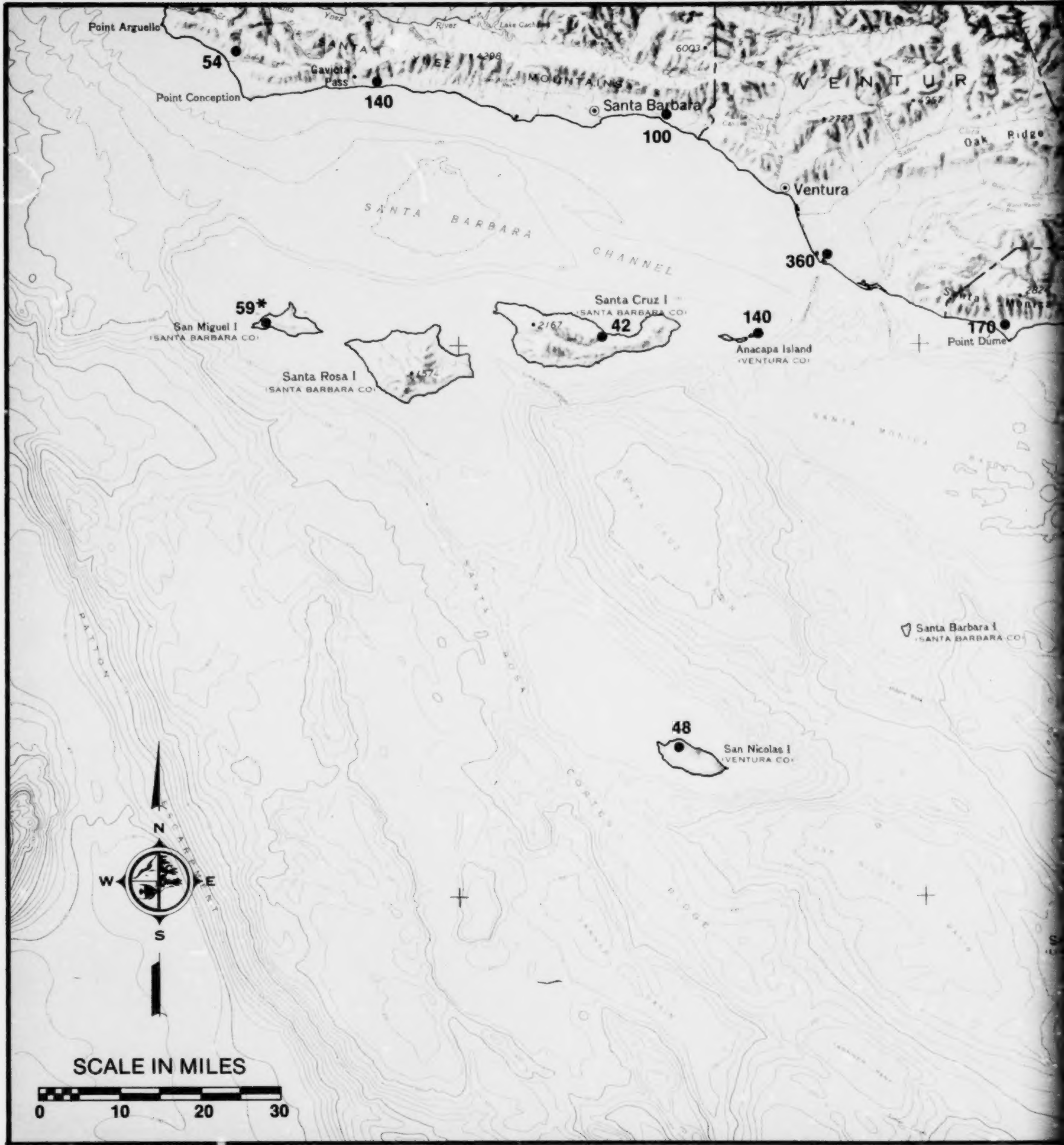
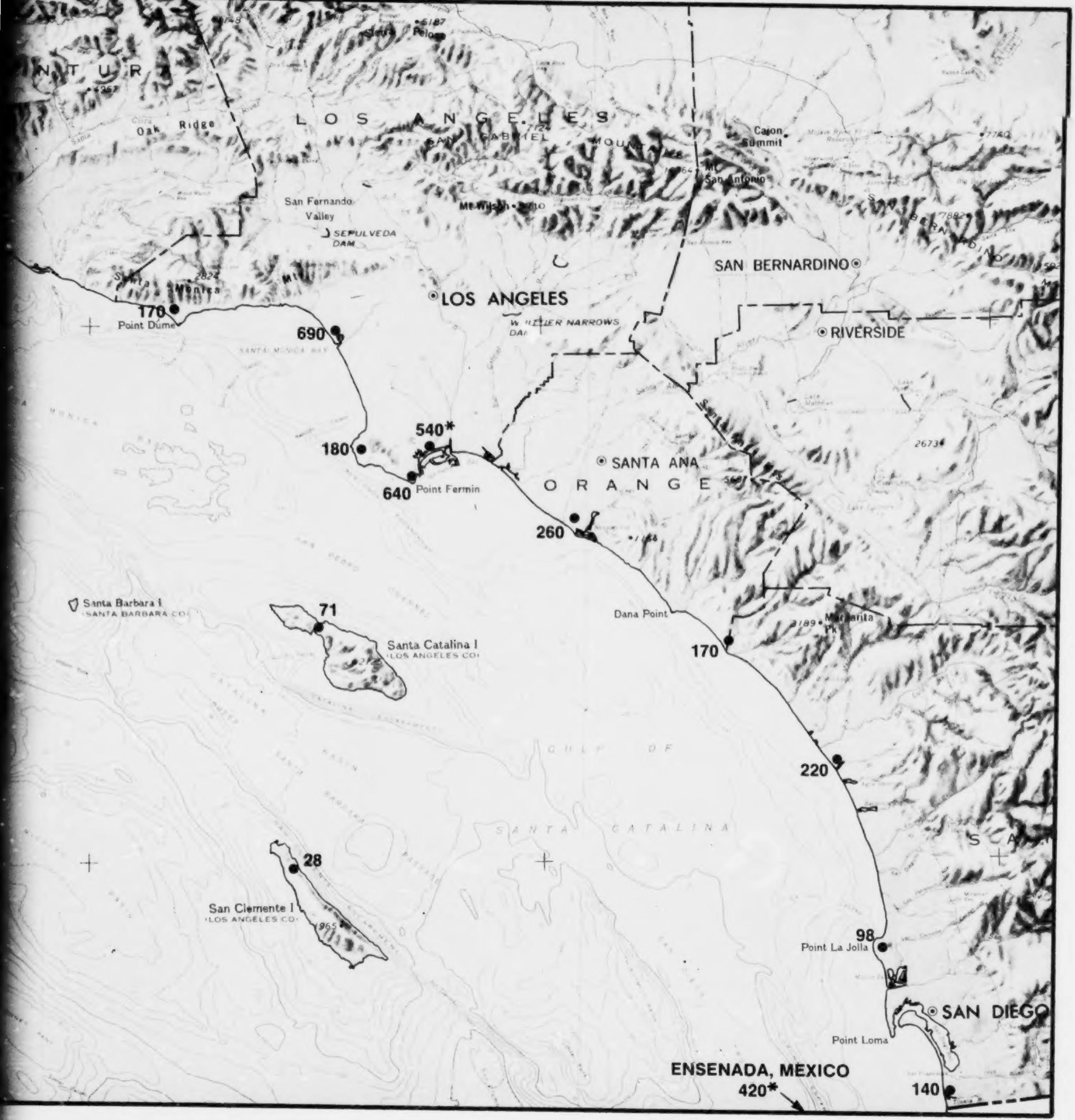

Point Arguello
54
Point Conception
Gaviota Pass
140
SANTA YNEZ MOUNTAINS
Santa Barbara
100
Ventura
VENTURA
Oak Ridge
SANTA BARBARA CHANNEL
360
59*
San Miguel I
(SANTA BARBARA CO)
Santa Rosa I
(SANTA BARBARA CO)
Santa Cruz I
(SANTA BARBARA CO)
42
140
Anacapa Island
(VENTURA CO)
170
Point Dume
Santa Barbara I
(SANTA BARBARA CO)
48
San Nicolas I
(VENTURA CO)
PATTON ESCARPMENT
N
S
W
E
SCALE IN MILES
0
10
20
30

Figure III-B-33. Average dry aerial fallout of total DDT during 1973 and 1974 for selected monitoring stations in the Southern California Bight in $g/m^2 \cdot day \times 10^{-9}$. The asterisk indicates 1973 only data. Depths are in fathoms (SCCWRP, 1975a).

A


NTUR
Oak Ridge
LOS ANGELES
SAN GABRIEL MOUNTAINS
Cajon Summit
Mt San Antonio
Mt Wilson
San Fernando Valley
SEPULVEDA DAM
Santa Monica Mts
170
Point Dume
LOS ANGELES
690
WHITTIER NARROWS DAM
SAN BERNARDINO
RIVERSIDE
540*
180
640
Point Fermin
SANTA ANA
ORANGE
260
Santa Barbara I
SANTA BARBARA CO
71
Santa Catalina I
LOS ANGELES CO
Dana Point
170
Margarita Pk
220
GULF OF SANTA CATALINA
28
San Clemente I
LOS ANGELES CO
98
Point La Jolla
SAN DIEGO
Point Loma
ENSENADA, MEXICO
420*
140

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B

7. SURFACE RUNOFF

Surface runoff can be divided into dry weather and storm flows. During storm periods the following constituents wash into storm drains, creeks, and rivers in the drainage basin to supplement normal dry weather flow:

- Organic matter such as leaves, grass clippings, decomposed trees to a minor extent, and fecal matter from dogs, cats, and other animals.
- Inorganic debris such as soil and silt particles.
- Dissolved minerals from soils.
- Dissolved nutrients from fertilizers washed from lawns and other planted areas including some agriculturally cultivated areas.
- Pesticides and herbicides.
- Minerals, nutrients, pesticides, herbicides, and other particulate matter in the atmosphere as discussed in Section III.B.6.
- Spills and leakages of fuels and lubricants and particles of rubber, metal, and brake linings resulting from motor vehicle operation and service.
- Small particles from industrial wastes which are deposited on ground and street surfaces.

Most dry weather flows result from controlled release of reservoirs, discharge of industrial and domestic wastes, and surface irrigation return water.

The drainage of the City of Los Angeles mainly flows into the Los Angeles River, Ballona Creek, and the Dominguez Channel. The San Gabriel River discharge, although not originating in the City of Los Angeles, affects the Los Angeles Harbor through ocean currents. The first three waterways drain primarily urban land, while the San Gabriel River services a great deal of agricultural and undeveloped land.

The water quality of runoff in these waterways has been monitored by the Los Angeles County Flood Control District and SCCWRP at the mouths of the major streams. Most of the dissolved and suspended substances washed into the waterways traverse the entire length of the Basin, especially in the lined waterways, so that the impact of runoff waste loads is greatest in the receiving waters.

Concentrations of various average wet and dry weather runoff constituents for the four described tributaries have been measured and the data are available in the Facilities Plan. The data may not be valid, however, since identical values were reported for most of the constituents in three of the four tributaries, and several constituents

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were identical for both wet and dry runoff in the same three tributaries. The bulk of the mass emissions normally occurs during only a few days of wet weather in the rainy season. The initial heavy rains transport erosion products such as silt and organic matter as well as heavy metals and hydrocarbons in a controlled "flash flood" fashion. Much of the mass transport of each flood-borne constituent is flushed through the harbors and bays to be dissipated throughout the Southern California Bight. It should be noted, also, that a considerable amount of storm runoff enters the sanitary sewer system through perforated manhole lids and infiltration and is subsequently discharged through the municipal waste outfalls.

6

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C. biological environment and artificial impacts

C. BIOLOGICAL ENVIRONMENT AND ARTIFICIAL IMPACTS

1. PRINCIPLES AND STUDIES ESTABLISHING POSSIBLE EFFECTS OF WASTEWATER AND SLUDGE CONSTITUENT ON THE MARINE BIOLOGY

Waste constituents entering the waters of the Southern California Bight that are likely to affect organisms or biological interactions include chemical elements, ions, compounds, radioactive isotopes, sediments, heat, bacteria, and viruses. All of these categories of pollutants are released in municipal wastewater discharges in general, and by both of the City of Los Angeles sewage treatment plants with marine outfalls, the Hyperion Treatment Plant (HTP) and the Terminal Island Treatment Plant (TITP).

Transfer of food through the marine ecosystem involves a complex interaction of predators, prey, and decomposers known as the aquatic food web (Figure III-C-1). Wastewater and sludge constituents may enter the food web as nutrients, toxicants, other physical and chemical constituents, and pathogens. A discussion of these constituents and their influence on the marine biology of the Southern California Bight follows.

a. General Principles.

(1) NUTRIENTS. Nutrients are substances required by marine organisms (notably phytoplankton) for growth. The nutrients which are usually limiting to phytoplankton growth are nitrate, phosphate, and silicate ions, particularly nitrates (SCCWRP, 1973). When these nutrients are added to the euphotic zone of the surface waters, where sunlight penetrates, the abundance of phytoplankton usually increases (biostimulation). Phytoplankton and benthic algae constitute the base of the marine food web, utilizing the energy in sunlight to convert carbon dioxide dissolved in the water into carbohydrates and incorporating the nitrogen and other nutrients from the water into proteins and other biological chemicals. The phytoplankton that are not eaten by zooplankton, nektonic invertebrates, benthos, or fish eventually sink to ocean floor when they provide a source of food for macro- and micro-benthic organisms directly or where they become part of organic debris. Decomposition by microorganisms may also occur in the water column as the organisms slowly sink towards the bottom. Phytoplankton utilize most of the nutrients that reach the euphotic zone, while those nutrients remaining below the euphotic zone

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may be taken up by zooplankton and other animals or may not enter the food web at all. Water below the euphotic zone is periodically transferred to the surface by the process of upwelling which distributes nutrients and toxicants throughout the water column. The general contribution of nutrients from HTP effluent to the fishery is discussed later in this Section.

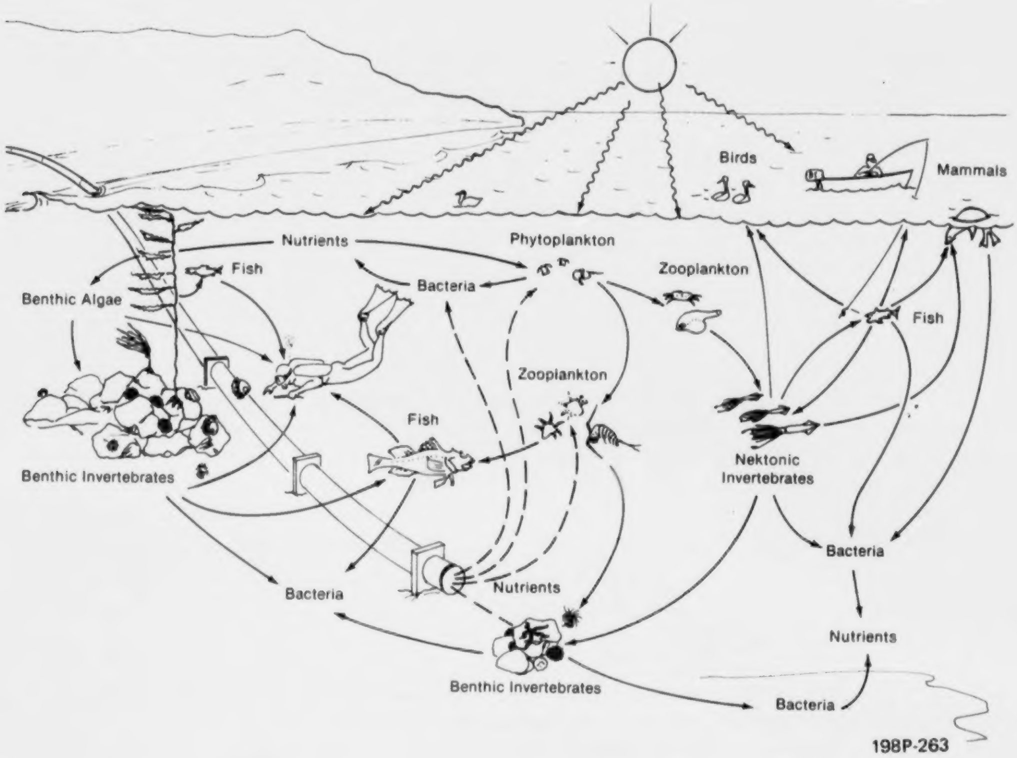
Birds
Mammals
Nutrients
Phytoplankton
Zooplankton
Fish
Bacteria
Benthic Algae
Zooplankton
Fish
Fish
Benthic Invertebrates
Nektonic Invertebrates
Bacteria
Bacteria
Nutrients
Nutrients
Benthic Invertebrates
Bacteria
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Figure III-C-1. Schematic representation of a typical food web in the Southern California Bight showing the influence of a wastewater discharge. Commercial harvesting of kelp and fish are not shown. Some of the pathways will vary with changing habitat types within the Bight, as in areas where there is no benthic algae.

(2) TOXICANTS. Toxicants are chemicals that have toxic physiological effects at some concentration. The toxicants considered in this report are trace metals, chlorinated hydrocarbons, and other potentially toxic substances including phenols and cyanide. In the concentrations that are legally discharged to the waters of the Southern California Bight, most of these chemicals cause only sublethal, if any, effects in

the exposed organisms (although direct lethal toxicity occurs to some benthic organisms exposed directly to sewage sludge). The sublethal effects may sufficiently alter a species' (or organism's) ability to compete through altered behavior or reduced reproductive success so that the species is displaced.

Although toxicants may be released from sewage outfalls in low concentrations and be diluted even more by mixing with the ocean waters, many marine organisms are able to concentrate these toxicants in their tissues (bioaccumulation). Toxicants in the water in concentrations too low to cause any noticeable effect in short-term laboratory tolerance studies, may be concentrated in the organism's tissues to the point that lethal or sublethal damage is done. Or, the concentrated toxicants may then be transferred through the food web with no detectable effect on the organism that did the concentrating in the first place. This transfer of toxicants from one trophic, or food, level to the next higher is known as biomagnification.

Predictions of the effects of progressive biomagnification on top carnivores (including marine birds, game fish, marine mammals, and man) must be approached cautiously because the rate of accumulation and body turnover time (often expressed as biological half-life) varies among species and among toxicants. The location within the body of the accumulated toxicants also varies among toxicants. Chlorinated hydrocarbons and some metals are characteristically accumulated in the liver. To a predatory fish or bird that eats its prey whole, the location of the toxicant in the prey is immaterial. To man, who eats only the muscle of most fish, it is of great importance.

Thus, toxicants released by sewage outfalls into the marine environment may reach man, the final consumer, by transfer or biomagnification through the marine food web. Toxicants entering the ocean from a point source (outfall) may have impacts far from where they are released. Toxicants released in the wastewater or eluted from the sludge particulates may be carried long distances by either currents in the ocean or dispersal in food organisms, and seafood containing appreciable concentrations of toxicants may thus occur far from the original sources of the toxicants.

(3) OTHER PHYSICAL-CHEMICAL PARAMETERS. Wastewater discharges in the ocean may alter the temperature, salinity, dissolved oxygen, and turbidity of the water in the vicinity of the outfall. Generally, effluent temperatures are higher and the salinity lower than that of the receiving seawater, thus causing the effluent to rise since it is less dense. Mixing with the seawater reduces the temperature and salinity differential between the effluent and the seawater so that there is little or no effect on the organisms in the area.

Wastewater discharges reduce the dissolved oxygen of the receiving waters through their high oxygen demands. Bacterial decomposition of the organic matter that settles to the sediments can cause anoxic conditions in the sediments and at the sediment-water interface. The extent of such anoxic areas depends on the physical characteristics of the outfall and the receiving waters as well as the organic load in the effluent. A dissolved oxygen content of 5 mg/l (ppm) has been recommended for the well being of organisms (SWRCB, 1965) although some species can survive in lower concentrations. Anoxic conditions, however, exclude all but a few organisms, notably anaerobic bacteria. Anoxic conditions also change the chemical form of many substances and thus their solubilities.

Settleable and suspended solids discharged in wastewaters decrease the water transparency in the immediate vicinity of the outfall. The extent and magnitude of the decreased transparency depends on the type of wastewater treatment, volume discharged, depth of the outfall, strength and depth of the thermocline, and local currents. In addition, the rising wastewater plume may also resuspend fine bottom sediments. Direct effects that may result from increased turbidity include a decrease in depth of the euphotic zone (and thus the primary productivity of the area), clogging of respiratory or filter mechanisms of organisms residing in or passing through the area, and providing a food source for filter feeders. Indirect effects may also occur through deposition of settleable solids on the bottom which may suffocate benthic organisms or alter the substrate to make it unsuitable for colonization by some organisms. Other potential indirect effects are an increase in the oxygen demand of the water and/or sediments near the outfall and the distribution of adsorbed toxic substances throughout the area.

Wastewater outfalls also alter the physical environment by providing a solid substrate (pipes and ballast) to which organisms can attach or orient themselves. In the case of the Hyperion outfalls, the pipes and shallow water ballast form an artificial reef providing a solid substrate and crevices in an area that has a predominantly soft bottom. The pipes also provide a reference point for schooling fish as well as a possible food source for some species. These "reefs" may enhance sport fishing productivity by providing habitat and food. However, they also help to aggregate organisms near a concentrated source of pollutants which could be accumulated by the organisms and subsequently passed on through the food web.

The altered conditions in the vicinity of outfalls resulting from wastewater and sludge discharges provide tolerant organisms with the ecological advantage of both decreased predation and competition for food and space. Thus, tolerant forms may dominate the effluent enriched area where they would not normally occur in great numbers if it were not for the outfall.

(4) DISEASES. Marine biota exposed to waste effluent may develop diseases or abnormalities themselves, or transfer pathogens to predators including man. Naturally occurring diseases of marine organisms may occur with a higher incidence rate than normal due to the stresses imposed by effluent constituents.

(5) BACTERIA AND VIRUSES. Pathogenic bacteria and viruses contained in wastewater discharges constitute a potential public health hazard. Humans may be exposed to these organisms through recreational use of contaminated waters or by eating contaminated shellfish. Another public health concern is the drug resistance (R factor) found in enterobacteria which may be transferred to humans via the above-mentioned pathways.

b. Studies Establishing Possible Effects of Wastewater Discharges and Artificial Impacts. Most of the studies that have been conducted to detect effects of the wastewater discharges of Hyperion Treatment Plant (HTP) on the marine biology have consisted of collecting organisms and examining some aspect of their biology. The most extensive sampling has been conducted with the intent of characterizing the general ecology of populations of marine organisms in the vicnity of the outfalls. Organisms have been sampled by underwater photography, by videotaping, by taking a grab or core sample of the benthic sediments with a variety of clamshell or core samplers, by netting with plankton nets or otter trawls, and by hook and line fishing. Table III-C-1 lists all of the recent sampling programs and the techniques used near the HTP outfalls.

Once the organisms are collected, they are examined for abundance (number per area), biomass (mass per area), and productivity (rate of production of new organisms over time). These characteristics of populations can establish whether the organisms are benefiting from nutrients or being damaged or displaced by toxicants. The samples are also often examined for species diversity. One of the usual characteristics of an environmental disturbance or stress is a reduction in the number of species in a given area although there may be an increase in the abundance and biomass of pollution-tolerant species. This is reflected in a decreased index of diversity. The distribution and abundance of individual species is one of the best ways of monitoring an environmental stress.

In an area influenced by sewage there may be no difference in the total abundance of organisms or in their total biomass, but nevertheless a replacement of a pollution intolerant species by tolerant ones. The species may be in the same genus, and are often in the same family so that examination of the distribution of higher taxonomic groups (such as the distribution of the phyllum Mollusca) would be less likely to reflect the influences of sewage than would the distribution of single molluscan species (such as the clam, *Solemya,* which has been found in abundance near the end of the 7-mile outfall). Hyperion Treatment Plant has reported the abundance and distribution of higher taxonomic groups in the sediments near the HTP outfalls in its annual reports, and these results are displayed on maps in this report. It has also identified most of the organisms to species, and some of those data are included in this report as well, but most have not yet been analyzed.* The benthos data are

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*HTP recently supplied the raw data sheets to Henningson, Durham & Richardson Ecosciences Division, but computer analysis and mapping has not yet been done.

Table III-C-1. Biological studies relative to the Hyperion Treatment Plant outfalls.

AGENCY	STUDY DATES	TYPE OF STUDY	ORGANISMS
Stevenson and Grady (Dept. of Geology, USC.)	1955 - 56	Nets	Phytoplankton
CalCOFI	1957 - 69	Nets	Zooplankton
Resig, J.M. (Allan Hancock Foundation)	1957 - 59	Whole Water	Phytoplankton
Thomas, W.H.(Scripps Inst. Oceanography)	1971 - 72	Whole Water	Phytoplankton
City of Los Angeles (HTP)	1957 - 70	Nets	Phytoplankton & Zooplankton
	August 1971	Grab Samples	Benthos
	November 1971	Otter Trawls	Fish
	January-February, July, November 1972	Grab Samples	Benthos
	January & July 1973	Grab Samples	Benthos
	January & July 1974	Grab Samples	Benthos
	January & July 1975	Grab Samples	Benthos
City of Los Angeles (HTP) and California Dept. of Fish and Game	1958 - 63 Quarterly	Otter Trawls	Fish and Benthos
City of Los Angeles (HTP) and Los Angeles and Orange Counties	February and June 1971	Otter Trawls	Fish
City of Los Angeles (HTP) and SCCWRP	September 1971 May - June 1972	Otter Trawls	Fish
SCCWRP	September 1972	Otter Trawls	Fish
	April 1973	Otter Trawls	Fish
	June - July 1974	Photography of outfalls by SCUBA and submarine	Fish and Benthos
	March - May 1975	Hook and Line	Fish

currently the most useful in analyzing the ecological consequences of the HTP outfalls. Hyperion Treatment Plant has also sampled and identified plankton in the water of Santa Monica Bay for 14 years, but these data also have yet to be processed, and the only plankton studies for which analyzed data are available ended in 1972. There are a number of fish sampling studies as well that have established the presence of fish near the outfalls, but which are generally inconclusive about the overall ecological effects of HTP effluent and sludge. These studies are all discussed below.

Another class of study is the examination of organisms for uptake and accumulation of sewage-derived substances. Studies of this type have been sporadic and have been limited to benthic organisms and fish in the vicinity of the HTP outfalls. The results of all of these studies are included in the report. Similarly, there has been some examination of organism collected near the outfalls for sewage related diseases and abnormalities, and these results are reported as well.

Finally, the extrapolation of toxicity information from laboratory studies and from field studies elsewhere is an important tool for predicting adverse effects of sewage constituents on the marine biology. Similarly, where it is difficult or experimentally impractical to determine if there has been biostimulation (increases in productivity) in the marine ecosystem resulting from the addition of nutrients and organic food, calculations of increased productivity can be made based on known effects of nutrients in similar systems. Both kinds of analysis are made in this report.

2. DISTRIBUTIONS, ABUNDANCES, AND PROBABLE ARTIFICIALLY INDUCED IMPACTS OF SEWAGE EFFLUENT ON MARINE ORGANISMS IN THE SOUTHERN CALIFORNIA BIGHT AND IN SANTA MONICA BAY

In this section, the existing biological setting of the entire Southern California Bight as it potentially relates to wastewater discharge is described. The discussion includes information on Santa Monica Bay and the Los Angeles Harbor, where the main Los Angeles City wastewater and sludge outfalls are located, but also presents detailed biological information from San Diego Bay and other areas where biological studies have been conducted. The reasons for this relatively broad scope of coverage are that:

- Many of the species of organisms potentially influenced by wastewater and sludge discharges are widespread, either sessile and occupying specific habitat types throughout the Bight, or mobile and capable of moving about within the Bight.
- Biological studies of different types or detail have been made in the different areas, but all may be relevant to the effects of discharges originating in Los Angeles. Some of the most detailed work has been done in San Diego Bay and is included because many of the organisms studied there have not been studied elsewhere although they may occur in the vicinity of Los Angeles City outfalls.

Distribution and Abundance. Organism species, abundance, biomass, and productivity are reported where measurements have been made because of the possibility that sewage effluents may alter species composition, standing crop (biomass), and productivity.

Diseases and Abnormalities. Diseases and abnormalities are reported because toxic constituents of sewage effluents may cause or contribute toward these problems. Uptake of toxic substances is discussed because of the potential damage toxic constituents of sewage may cause to the organisms concentrating them, and because of potential damage to consumers higher up in the food web (including man).

Potential Biological Impacts of HTP Wastewater and Sludge Constituents. Many of the constituents of HTP sludge and wastewater effluent are released in concentrations which may have direct toxic effects on marine organisms. These substances and their effects on invertebrates and fish in laboratory studies are summarized in Tables III-C-2 and 3. These tables summarize the detailed information presented on toxicity in the following

Table III-C-2. Comparison of constituents measured in HTP wastewater with marine algae and invertebrate bioassays reported in the literature. Potential effects of the various effluent treatments are designated in the bioassay column by effluent column superscripts.

CONSTITUENT	CONCENTRATION (mg/l = ppm)					TAXA	EFFECT	REFERENCES
	A 5-MILE EFFLUENT^1	B 7-MILE EFFLUENT^1	C PRIMARY TREATMENT^2	D SECONDARY TREATMENT^3	BIOASSAY^4			
DDT	0.00072	0.00259	-^{5}	-^{5}	>10.0	European Cockle, *Cardium edule*	48-hr LC_{50}	SCCWRP, 1973
					>10.0	Quahog clams, *Mercenaria mercenaria*	96-hr LC_{50}	SCCWRP, 1973
					10.0	Mud Snail *Nassa obsoleta*	96-hr LC_{50}	SCCWRP, 1973
					1.0	Oyster adults, *Crassostrea virginica*	90% decrease in growth, 3-4 days	SCCWRP, 1973
					0.034	Oyster larvae, *Crassostrea virginica*	14-day LC_{50}	SCCWRP, 1973
					0.025	Oyster adults, *Crassostrea virginica*	50% decrease in growth, 12 days	SCCWRP, 1973
					0.010	Phytoplankton	Inhibited growth	SCCWRP, 1973
					0.010-0.003	European brown Shrimp, *Crangon crangon*	48-hr LC_{50}	SCCWRP, 1973
					0.006	Hermit crab, *Pagurus longicarpus*	48-hr LC_{50}	SCCWRP, 1973
					0.0051	Grass shrimp, *Palaemonetes vulgaris*	48-hr LC_{50}	SCCWRP, 1973
					0.0050	Crab larvae, *Cancer magister & C. productus*	72-hr LC_{100}	SCCWRP, 1973
					0.002^B	Quahog clams, *Mercenaria mercenaria*	Inhibited glycolytic and glucogenic enzyme activity	SCCWRP, 1973
					0.001^B	Oyster adults, *Crassostrea virginica*	20% decrease in shell deposition and growth	SCCWRP, 1973
					0.001^B	Sand shrimp, *Crangon septemspinosa*	48-hr LC_{50}	SCCWRP, 1973
					0.00012^{AB}	Shrimp	28-day LC_{100}	SCCWRP, 1973
					0.0001^{AB}	Penaeid shrimp, *Penaeus aztecus*	Caused abnormal tactile & chemoreceptor responses	SCCWRP, 1975b
					0.00005^{AB}	Pink shrimp, *Penaeus duorarum*	Inhibited enzyme activity	SCCWRP, 1975b
					0.00001^{AB}	Copepod larvae, *Pseudodiaptomus sp.*	Inhibited development	SCCWRP, 1975b
Endosulfan	-^{5}	-^{5}	-^{5}	-^{5}	0.450	Bay mussel, *Mytilus edulis*	50% reduction in byssal thread formation at 15°C in 24 hours	Roberts, 1975
					0.800	Queen scallop, *Chlamys operularis*	50% reduction in byssal thread formation at 15°C in 24 hours	Roberts, 1975
Trichlorphon	-^{5}	-^{5}	-^{5}	-^{5}	30	Bay mussel, *Mytilus edulis*	50% reduction in byssal thread formation at 15°C in 24 hours	Roberts, 1975
PCB's	0.00036^6	0.0033^6	-^{5}	-^{5}	>10 - 3	European cockle, *Cardium edule*	48-hr LC_{50}	SCCWRP, 1973
					>10 - 0.3	European brown shrimp, *Crangon crangon*	48-hr LC_{50}	SCCWRP, 1973
					0.1	Juvenile pink shrimp, *Penaeus duorarum*	48-hr LC_{100}	SCCWRP, 1973
					0.005	Juvenile pink shrimp, *Penaeus duorarum*	20-day LC_{72}	SCCWRP, 1973
					0.003^B	Invertebrates	Caused hepatopancreatic cellular alterations	SCCWRP, 1975b
					0.001^B	Invertebrates	Caused brachial necrosis alterations	SCCWRP, 1975b

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Table III-C-2 (Cont.)

CONSTITUENT	CONCENTRATION (mg/l = ppm)					TAXA	EFFECT	REFERENCES
	A 5-MILE EFFLUENT[1]	B 7-MILE EFFLUENT[1]	C PRIMARY TREATMENT[2]	D SECONDARY TREATMENT[3]	BIOASSAY[4]			
PCB's	0.0036[6]	0.0033[6]	-[5]	-[5]	0.001[B]	Oysters	Decreased shell growth 20%	SCCWRP, 1973
Aroclor 1242	-[5]	-[5]	-[5]	-[5]	0.9	Bay mussel, *Mytilus edulis*	50% reduction in byssal thread formation at 15°C in 24 hours	Roberts, 1975
Arcolor 1254	-[5]	-[5]	-[5]	-[5]	2.2	Bay mussel, *Mytilus edulis*	50% reduction in byssal thread formation at 15°C in 24 hours	Roberts, 1975
					0.0001	Diatoms, *Rhizosolenia setigera and*	Reduced growth	SCCWRP, 1975b
					0.0001	Diatoms, *Thalassiosira pseudonana*	Reduced growth	SCCWRP, 1975b
					0.0001	Green alga, *Dunaliella tertiolecta*	Reduced growth	SCCWRP, 1975b
Hg^{+2}	0.0032	0.154	0.0041	0.0024	180	Oyster larvae, *Crassostrea commercialis*	2-hr LC_{50}	SCCWRP, 1973
					13	Bay mussel larvae, *Mytilus edulis*	2-hr LC_{50}	SCCWRP, 1973
					10	Oysters	Heavy mortality after 3 days	Fowler, et al., 1975
					10	Clams	Heavy mortality after 5 to 7 days	Fowler, et al., 1975
					10-3.3	European brown shrimp, *Crangon crangon*	48-hr LC_{50}	SCCWRP, 1973
					10-3.3	European cockle, *Cardium edule*	48-hr LC_{50}	SCCWRP, 1973
					1.04	Polychaete, *Mercierella enigmatica*	Modified sublethal response	SCCWRP, 1973
					1.0	Polychaete, *Ophryotrocha labronica*	0.5-hr LC_{50}	Oshida, et al., 1976
					0.5	Bay mussel, *Mytilus eclulis*	Modified sublethal response	SCCWRP, 1973
					0.14[B]	Tubeworm larvae, *Spirobis*	2-hr LC_{50}	SCCWRP, 1973
					0.10[B]	Bryozoan larvae, *Watersipora*	2-hr LC_{50}	SCCWRP, 1973
					>0.10[B]	Polychaete adults, *Capitella capitata*	96-hr LC_{50}	Oshida, et al., 1976
					0.10[B]	Polychaete adults, *Capitella capitata*	28-day LC_{50}	Oshida, et al., 1976
					0.10[B]	Polychaete juveniles, *Neanthes arenaceodentata*	96-hr LC_{50}	Oshida, et al., 1976
					0.10[B]	Isopod, *Idotea emarginata*	LC_{50} >5 days	Jones, 1973
					0.10[B]	Isopod, *Idotea neglecta*	LC_{50} >5 days	Jones, 1973
					0.09[B]	Polychaete juveniles, *Neanthes arenaceodentata*	28-day LC_{50}	Oshida, et al., 1976
					0.032[B]	Bay mussel embryos, *Mytilus*	Abnormal development	Oshida, et al., 1976
					0.032[B]	Oyster, *Crassotrea*	Abnormal development	SCCWRP, 1973
					0.022[B]	Polychaete adults, *Neanthes arenaceodentata*	96-hr LC_{50}	Oshida, et al., 1976
					0.017[B]	Polychaete adults, *Neanthes arenaceodentata*	28-day LC_{50}	Oshida, et al., 1976

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Table III-C-2 (Cont.)

CONSTITUENT	CONCENTRATION (mg/l = ppm)					TAXA	EFFECT	REFERENCES
	A 5-MILE EFFLUENT[1]	B 7-MILE EFFLUENT[1]	C PRIMARY TREATMENT[2]	D SECONDARY TREATMENT[3]	BIOASSAY[4]			
Hg^{+2} (cont)	0.0032	0.154	0.0041	0.0024	0.014^{B}	Polychoete trochophore larvae, *Capitella capitata*	96-hr LC_{50}	Oshida, et al., 1976
					0.010^{C}	Invertebrates	Increased respiration	SCCWRP, 1975b
					0.005^{B}	Protozoan, *Christigera*	Caused 12% growth retardation	Gray and Ventilla,1973
					0.003^{ABC}	Isopod, *Sphaeroma pentodon*	Induced morphological changes	SCCWRP, 1975b
					$0.002\text{-}0.0015^{ABCD}$	Sea urchin embryos, *Paracentrotus*	Abnormal development	SCCWRP, 1973
Ag^{+1}	0.02	0.04	0.03	0.019	0.4	Barnacle	48-hr LC_{50}	SCCWRP, 1973
					0.00016^{ABCD}	Sea urchin embryo, *Paracentrotus*	Abnormal development	SCCWRP, 1973
Zn^{+2}	0.24	23.9	0.34	0.23	330-100	European brown shrimp, *Crangon crangon*	48-hr LC_{50}	SCCWRP, 1973
					330-100	European Cockle, *Cardium edule*	48-hr LC_{50}	SCCWRP, 1973
					100	Oyster adult, *Ostrea edulis*	96-hr LC_{50}	SCCWRP, 1973
					30	Barnacle adult, *Balanus balanoides*	90% kill in 2 days	Becker & Thatcher,1973
					10^{B}	Giant kelp, *Macrocystis pyrifera*	50% inhibition of photosynthesis in 4 days	Becker & Thatcher,1973
					8^{B}	Barnacle adult, *Balanus balanoides*	90% kill in 5 days	Becker & Thatcher,1973
					5.2^{B}	Bryozoan larvae, *Bugula*	2-hr LC_{50}	SCCWRP, 1973
					4.9^{B}	Tubeworm larvae, *Spirorbis*	2-hr LC_{50}	SCCWRP, 1973
					3.5^{B}	Polychaete adult, *Capitella capitata*	96-hr LC_{50}	Oshida, et al., 1976
					3.2^{B}	Osyter embryos, *Crassotrea*	Abnormal development	SCCWRP, 1973
					1.8^{B}	Polyechaete adult, *Neanthes arenaceodentata*	96-hr LC_{50}	Oshida, et al., 1976
					1.7^{B}	Polychaete trochophore larvae, *Capitella capitata*	96-hr LC_{50}	Oshida, et al., 1976
					1.4^{B}	Polychaete adult, *Neanthes arenaceodentata*	28-day LC_{50}	Oshida, et al., 1976
					1.25^{B}	Polychaete adult, *Capitella capitata*	28-day LC_{50}	Oshida, et al., 1976
					1.0^{B}	Polychaete adult, *Ophryotrocha labronica*	13-hr LC_{50}	Oshida, et al., 1976
					1.0^{B}	Mussel embryos, *Mytilus edulis*	Abnormal development	SCCWRP, 1973
					$\sim 1.0^{B}$	Oyster larvae, *Ostrea eclulis*	96-hr LC_{50}	SCCWRP, 1973
					0.9^{B}	Polychaete juveniles, *Neanthes arenaceodentata*	96-hr LC_{50}	Oshida, et al., 1976
					0.32^{BC}	Sea urchin eggs, *Anthocidaris sp.*	Abnormal development 27C	Becker & Thatcher,1973

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Table III-C-2 (Cont.)

CONSTITUENT	CONCENTRATION (mg/l = ppm)					TAXA	EFFECT	REFERENCES
	A 5-MILE EFFLUENT[1]	B 7-MILE EFFLUENT[2]	C PRIMARY TREATMENT[2]	D SECONDARY TREATMENT[3]	BIOASSAY[4]			
Zn^{+2} (cont)	0.24	23.9	0.34	0.23	0.32^{BC}	Pacific oyster egg, *Crassostrea gigas*	Abnormal development, 27C	Becker & Thatcher,1973
					0.25^{BC}	Diatom, *Nitzschia closterium*	Division rate reduced	Becker & Thatcher,1973
					0.25^{BC}	Protozoan, *Christigera*	ILm (median inhibitory level, 1/2 control growth rate)	Gray and Ventilla,1973
					0.16^{ABCD}	Sea urchin egg, *Psammechinus miliaris*	Abnormal fertilization and cleavage	Becker & Thatcher,1973
					0.03^{ABCD}	Sea urchin larvae, *Paracentrotus lividus*	Growth retarded	Becker & Thatcher,1973
Cu^{+2}	0.19	13.9	0.22	0.11	200-50	Barnacle, *Elminius modestus*	2-5 hr LC_{50}@pH 8.1, 21-25C	Becker & Thatcher,1973
					50-15	Barnacle, *Elminius modestus*	2-25 hr LC_{50} @pH 8.1, 21-25C	Becker & Thatcher,1973
					33-10	European brown shrimp, *Crangon crangon*	48-hr LC_{50}	SCCWRP, 1973
					30.0	Barnacle nauplii, *Balanus crenatus*	Killed in 2 hrs	Becker & Thatcher,1973
					30.0	Barnacle nauplii, *Balanus balanoides*	Killed in 2 hrs	Becker & Thatcher,1973
					22.2	Bay mussel, *Mytilus edulis*	2-hr LC_{50}	SCCWRP, 1973
					20.0	Barnacle larvae, *Elminius modestus*	10-hr LC_{50}	SCCWRP, 1973
					10.0^{B}	Barnacle adults, *Balanus crenatus*	Killed in 2 hrs	Becker & Thatcher,1973
					10.0^{B}	Barnacle adults, *Balanus balanoides*	Killed in 2 hrs	Becker & Thatcher,1973
					$8-2.5^{B}$	Copepod, *Acartia clausi*	2-3 hr LC_{50}	Becker & Thatcher,1973
					4.9^{B}	Barnacle cyprids	Lethal, 1 day	Becher & Thatcher,1973
					$2.5-1.0^{B}$	Copepod, *Acartia clausi*	3-14 hr LC_{50}	Becker & Thatcher,1973
					$2.0-1.0^{B}$	Shore crab, *Carcinus maenas*	Threshold toxicity, 11-12 days	Becker & Thatcher,1973
					1.9^{B}	Pacific oyster, *Crassostrea gigas*	96-hr LC_{50}	Becher & Thatcher,1973
					1.5^{B}	Polychaete, *Nereis virens*	Killed in 2-3 days	Becker & Thatcher,1973
					1.3^{B}	Phytoplankton	K^{+} loss and membrane damage	SCCWRP, 1976
					1.0^{B}	European cockle, *Cardium edule*	48-hr LC_{50}	SCCWRP, 1973
					0.8^{B}	American oyster larvae	Lethality	SCCWRP, 1973
					0.57^{B}	Bryozoan larvae, *Watersipora*	2-hr LC_{50}	SCCWRP, 1973
					0.51^{B}	Tubeworm larvae, *Spirorbis*	2-hr LC_{50}	SCCWRP, 1973
					0.5^{B}	Polychaete, *Nereis virens*	Killed in 4 days	Becker & Thatcher,1973
					0.5^{B}	Barnacle cyprids	Inactive after 24 hrs	SCCWRP, 1973

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Table III-C-2 (Cont.)

CONSTITUENT	CONCENTRATION (mg/l = ppm)					TAXA	EFFECT	REFERENCES
	A 5-MILE EFFLUENT^1	B 7-MILE EFFLUENT^1	C PRIMARY TREATMENT^2	D SECONDARY TREATMENT^3	BIOASSAY^4			
Cu^{+2} (cont)	0.19	13.9	0.22	0.11	0.1^{ABCD}	Polychaete, *Nereis virens*	Threshold toxicity, 21 days	Becker & Thatcher,1973
					0.1^{ABC}	Bay mussel, *Mytilus edulis*	5% dead, 7 days, 10C	Becker & Thatcher,1973
					0.1^{ABC}	Giant kelp, *Macrocystis pyrifera*	50% inhibition of photosynthesis in 4 days	Becker & Thatcher,1973
					0.1^{ABC}	Limpet, *Acmaea scabra*	Lethal, 3 days	Becker & Thatcher,1973
					0.1^{ABC}	Green abalone, *Haliotis fulgens*	100% kill, 3 days	Becker & Thatcher,1973
					0.1^{ABC}	Gastropod, *Astraea undosa*	100% kill, 5 days	Becker & Thatcher,1973
					0.1^{ABC}	Gastropod, *Tegula spp.*	100% kill, 15-25 days	Becher & Thatcher,1973
					0.1^{ABC}	Sea urchin, *Anthocidaris sp.*	Effect on egg development, 27C	Becher & Thatcher,1973
					0.1^{ABC}	Sea urchin, *Hemicentrotus sp.*	Effect on egg development, 11-16C	Becher & Thatcher,1973
					0.1^{ABC}	Pacific oyster, *Crassotrea gigas*	Effect on egg development 11-16C	Becher & Thatcher,1973
					0.1^{ABC}	Polychaete, *Phyllodoce maculata*	7-day LC_{50}	Oshida, et al., 1976
					0.1^{ABC}	Polychaete, *Ophryotrocha labronica*	No reproduction	Oshida, et al., 1976
					0.08^{ABCD}	Bay mussel, *Mytilus edulis*	Modified sublethal response	SCCWRP, 1973
					0.08^{ABC}	Polychaete, *Mercierella enigmatica*	Modified sublethal response	SCCWRP, 1973
					0.05^{ABCD}	Bryozoan	Deleterious to all stages of development	Becker & Thatcher,1973
					0.05^{ABCD}	Sea urchin, *Paracentrotus lividus*	Lethal	Becker & Thatcher,1973
					0.05^{ABCD}	Gastropod, *Astraea undosa*	100% kill, 14 days	Becker & Thatcher,1973
					0.05^{ABCD}	Diatoms and dinoflagellates	Toxic, 20C	Becker & Thatcher,1973
					0.04^{ABCD}	Bivalve larvae	Lethal	Becker & Thatcher,1973
					0.03^{ABCD}	Dinoflagellate, *Gymnodinium breve*	Minimum amount lethal	Becker & Thatcher,1973
					0.03^{ABCD}	Sea urchin, *Paracentrotus lividus*	Growth of arms disturbed	Becker & Thatcher,1973
					0.025^{ABCD}	Polychaete, *Ophryotrocha labronica*	Growth rate inhibited	Oshida, et al., 1976
					0.024^{ABCD}	Barnacle cyprids	Attachment prevented	Becker & Thatcher,1973
					$<0.02^{ABCD}$	Clam, *Mya arenaria*	Extremely toxic	Becker & Thatcher,1973
					0.02^{ABCD}	Isopod, *Neosphaeroma oregonensis*	First apparent significant response	Becker & Thatcher,1973
					$0.02-.01^{ABCD}$	Sea urchin, *Paracentrotus lividus*	Slowed growth of pluteus	Becker & Thatcher,1973
					0.005^{ABCD}	Isopod, *Sphaeroma pentodon*	Modified sublethal response	SCCWRP, 1973
					$0.00265-0.00055^{ABC}$	Phytoplankton (9 spp.)	Growth inhibited, 7 spp., 20C	Becker & Thatcher,1973
					0.001^{ABCD}	Polychaete, *Nereis diversicolor*	30-50 hr LC_{50}, taken from low Cu sediments	Becker & Thatcher,1973
					0.001^{ABCD}	Polychaete, *Neris diversicolor*	100 hr LC_{50}, taken from high Cu sediments	Becker & Thatcher,1973

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Table III-C-2 (Cont.)

CONSTITUENT	CONCENTRATION (mg/l = ppm)					TAXA	EFFECT	REFERENCES
	A 5-MILE EFFLUENT[1]	B 7-MILE EFFLUENT[2]	C PRIMARY TREATMENT[2]	D SECONDARY TREATMENT[3]	BIOASSAY[4]			
Cu^{+2} (cont)	0.19	13.9	0.22	0.05	$< 0.5^{B}$	Prawn, *Leander squilla*	Toxcity threshold	SCCWRP, 1973
					$0.5-0.33^{B}$	European brown shrimp, *Crangon crayon*	Detection and avoidance	SCCWRP, 1973
					$0.5-0.13^{ABC}$	Pacific oyster, *Crassostrea gigas*	Accumulation of Cu, making unfit for food	Becker & Thatcher,1973
					0.32^{B}	Protozoan, *Colpidium comphylum*	ILm	Sudo and Aiba, 1973
					0.32^{B}	Bay mussel, *Mytilus edulis*	1st apparent significant responses	Becker & Thatcher,1973
					0.32^{B}	Polychaete, *Mercierella enigmatica*	1st apparent significant responses	Becker & Thatcher,1973
					$>0.3^{B}$	Bryozoan	No growth	Becker & Thatcher,1973
					$>0.3^{B}$	Bryozoan, *Bugula neritina*	Larvae cannot live	Becker & Thatcher,1973
					0.3^{B}	Polychaete adults and juveniles, *Neanthes arenaceodentata*	96-hr LC_{50}	Oshida, et al., 1976
					$0.3-0.2^{BC}$	Bryozoan, *Bugula neritina*	Growth retarded	Becker & Thatcher,1973
					0.27^{BC}	Protozoan, *Opercularia sp.*	ILm	Sudo and Aiba, 1973
					0.25^{B}	Protozoan, *Vorticella microstoma*	ILm	Sudo and Aiba, 1973
					0.2^{BC}	Bay mussel, *Mytilus edulis*	55% dead, 7 days, 10C threshold toxicity	Becker & Thatcher,1973
					0.2^{BC}	Polychaete adult, *Capitella capitata*	96-hr LC_{50}	Oshida, et al., 1976
					0.2^{BC}	California mussel, *Mutilus californicus*	100% kill, 2 days	Becker & Thatcher,1973
					0.2^{BC}	Bay mussel, *Mytilus edulis*	100% kill, 17 days	Becker & Thatcher,1973
					0.25^{B}	Polychaete adult, *Neanthes arenaceodentata*	28-day LC_{50}	Oshida, et al., 1973
					0.2^{BC}	Mollusc, *Fusinus kobeli*	100% kill, 8 days	Becker & Thatcher,1973
					0.18^{ABC}	Polychaete trochophore larvae, *Capitella capitata*	96-hr LC_{50}	Oshida, et al., 1973
					0.16^{ABC}	Sea urchin, *Psammechinus miliaris*	Noticeable abnormalities	Becker & Thatcher,1973
					0.15^{ABC}	Chiton, *Ischnochiton conspicuous*	100% kill, 10 days	Becker & Thatcher,1973
					0.14^{ABC}	Polychaete juvenile, *Neanthes arenaceodentata*	28-day LC_{50}	Oshida, et al., 1976
					0.14^{ABC}	Bay mussel, *Mutilus edulis*	3-4 day lethality after 0.5-3 day exposure	SCCWRP, 1973
					0.12^{ABC}	Polychaete, *Phyllodoce maculata*	4-day LC_{50}	Oshida, et al., 1976
					0.12^{ABC}	Barnacle cyprids	Lethal, 10 days	Becker & Thatcher,1973

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Table III-C-2 (Cont.)

CONSTITUENT	CONCENTRATION (mg/l = ppm) A 5-MILE EFFLUENT[1]	B 7-MILE EFFLUENT[1]	C PRIMARY TREATMENT[2]	D SECONDARY TREATMENT[3]	BIOASSAY[4]	TAXA	EFFECT	REFERENCES
Cu^{+2} (cont)	0.19	13.9	0.22	0.05	0.0003^{ABCD}	Phytoplankton (1 sp.)	No growth	Becker & Thatcher,1973
					0.00025^{ABCD}	Polychaete, *Nereis diversicolor*	250-300 hr LC_{50}, taken low Cu sediments	Becker & Thatcher,1973
Cr^{+6}	0.8	0.2	0.0	0.0	200	Crab zoea, *Sesarma hematocheir*	24-hr LC_{50} w/K_2Cr_{04}	Oshida, et al., 1976
					60	Crab zoea, *Carcinus maenas*	3 week LC_{50} w/Na_2Cr_{04} · 10 H_2O	Oshida, et al., 1976
					56	Crab zoea, *Sesarma hematocheir*	24-hr LC_{50} w/$Cr_2\ (SO_4)_3$	Oshida, et al., 1976
					35	Clam, *Rangia cuneata*	96-hr LC_{50} w/$K_2Cr_2O_4$ at 22% salinity	Oshida, et al., 1976
					20.3	Protozoan, *Opercularia sp.*	ILm	Sudo and Aiba, 1973
					12.9	Protozoan, *Colpidium campylum*	ILm	Sudo and Aiba, 1973
					10	Urchin, *Anthocidaris crassipina*	24-hr affected egg development w/$Cr_2(SO_4)_3$	Oshida, et al., 1976
					10	Urchin, *Anthocidaris crassipina*	24-hr affected egg development w/$K_2Cr_2O_7$	Oshida, et al., 1976
					10	Urchin, *Hemicentrotus pulcherimus*	72-hr affected egg development w/$K_2Cr_2O_7$	Oshida, et al., 1976
					10	Bay mussel, *Mytilus edulis*	48-hr affected egg development w/$K_2Cr_2O_7$	Oshida, et al., 1976
					10	Bay mussel, *Mytilus edulis*	48-hr affected egg development $Cr_2(SO_4)_3$	Oshida, et al., 1976
					10	Pacific oyster, *Crassostrea gigas*	24-hr affected egg development w/$K_2Cr_2O_4$	Oshida, et al., 1976
					8.0	Polychaete trochophore larvae, *Capitella capitata*	96-hr LC_{50} w/CrO_3	Oshida, et al., 1976
					5.0	Polychaete adult, *Capitella capitata*	96-hr LC_{50} w/CrO_3	Oshida, et al., 1976
					4.3-2.2	Polychaete, *Neanthes arenaceodentata*	96-hr LC_{50} w/$K_2Cr_2O_4$	Oshida, et al., 1976
					4.0-3.0	Polychaete adult, *Neanthes arenaceodentata*	96-hr LC_{50} w/$K_2Cr_2O_4$	Oshida, et al., 1976
					3.2	Barnacle adult, *Balanus amphitrite albicostatus*	1-hr cessation of cirri movement w/$Cr_2(SO_4)_3$	Oshida, et al., 1976
					1.89-1.44	Polychaete, *Neanthes arenaceodentata*	7-day LC_{50} w/$K_2Cr_2O_4$	Oshida, et al., 1976
					1.7-1.4	Polychaete adult, *Neanthes arenaceodentata*	7-day LC_{50} w/$K_2Cr_2O_4$	Oshida, et al., 1976
					>1.0	Polychaete adult, *Neanthes arenaceodentata*	96-hr LC_{50} w/CrO_3	Oshida, et al., 1976
					>1.0	Polychaete juvenile, *Neanthes arenaceodentata*	96-hr LC_{50} w/CrO_3	Oshida, et al., 1976
					1.0	Polychaete, *Nereis virens*	3-week LC_{50} w/Na_2CrO_4	Oshida, et al., 1976

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Table III-C-2 (Cont.)

CONSTITUENT	CONCENTRATION (mg/l = ppm)					TAXA	EFFECT	REFERENCES
	A 5-MILE EFFLUENT[1]	B 7-MILE EFFLUENT[1]	C PRIMARY TREATMENT[2]	D SECONDARY TREATMENT[3]	BIOASSAY[4]			
Cr^{+6} (cont)	0.0	0.0	0.0	0.0	< 1.0	Urchin, *Hemicentrotus pulcherrimus*	72-hr affected egg development w/$Cr_2(SO_4)_3$	Oshida, et al., 1976
					0.7	Polychaete juvenile, *Neanthes arenaceodentata*	28-day LC_{50} w/CrO_3	Oshida, et al., 1976
					0.55	Polychaete adult, *Neanthes arenaceodentata*	28-day LC_{50} w/CrO_3	Oshida, et al., 1976
					0.53	Protozoan, *Voeticella Microstoma*	ILm	Sudo and Aiba, 1973
					0.3-0.2	Polychaete adult, *Neanthes arenaceodentata*	96-hr EC_{50} (mucous tube building) w/$K_2Cr_2O_7$	Oshida, et al., 1976
					0.28	Polychaete adult, *Capitella capitata*	28-day LC_{50} w/CrO_3	Oshida, et al., 1976
					0.1	Polychaete adult, *Neanthes arenaceodentata*	7-day EC_{50} (tube building) w/ $K_2Cr_2O_7$	Oshida, et al., 1976
					0.1	Polychaete adult, *Neanthes arenaceodentata*	440-day (3 generations) reproduction ceased w/$K_2Cr_2O_7$	Oshida, et al., 1976
					0.0125	Polychaete adult, *Neanthes arenaceodentata*	Brood size reduced w/$K_2Cr_2O_7$	Oshida, et al., 1976
Cr^{+3}	0.21	15.1	0.27	0.14	12.5[B]	Polychaete adult, *Neanthes arenaceodentata*	7-day 5% mortality w/$CrCl_3$	Oshida, et al., 1976
					10.3[B]	Oyster, *Crassotrea virginica*	EC_{50} (larval development) w/$CrCL_3$	Oshida, et al., 1976
Cr	-[5]	-[5]	-[5]	-[5]	300-100	European cockle, *Cardium edule*	48-hr LC_{50}	SCCWRP, 1973
					100	European brown shrimp, *Crangon crangon*	48-hr LC_{50}	SCCWRP, 1973
					10	Bryozoan, *Bugula*	Lethal in 5 hours	SCCWRP, 1973
					1.0	Urchin, *Paracentrotus*	Abnormal embryogenesis	SCCWRP, 1976
Cd^{+2}	0.02	1.27	0.03	0.02	12.5	Polychaete juvenile, *Neanthes arenaceodentata*	96-hr LC_{50}	Oshida, et al., 1976
					12.0	Polychaete adult, *Neanthes arenaceodentata*	96-hr LC_{50}	Oshida, et al., 1976
					11.0	Polychaete, *Nereis virens*	96-hr LC_{50}	Oshida, et al., 1976
					7.5	Polychaete adult, *Capitella capitata*	96-hr LC_{50}	Oshida, et al., 1976
					3.0	Polychaete adult, *Neanthes arenaceodentata*	28-day LC_{50}	Oshida, et al., 1976
					3.0	Polychaete juvenile, *Neanthes arenaceodentata*	28-day LC_{50}	Oshida, et al., 1976
					1.0[B]	Polychaete, *Ophryotrocha labronica*	410-hr LC_{50}	Oshida, et al., 1976
					0.7[B]	Polychaete adult, *Capitella capitata*	28-day LC_{50}	Oshida, et al., 1976

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Table III-C-2 (Cont.)

CONSTITUENT	CONCENTRATION (mg/l = ppm) A 5-MILE EFFLUENT[1]	B 7-MILE EFFLUENT[1]	C PRIMARY TREATMENT[2]	D SECONDARY TREATMENT[3]	BIOASSAY[4]	TAXA	EFFECT	REFERENCES
Cd^{+2} (cont)	0.02	1.27	0.03	0.02	0.36^{B}	Mussel, *Mytilus galloprovincialis*	30-day LC_{50}	Pavicic and Jaervenpaeae, 1974
					0.30^{B}	Invertebrates	Induced morphological changes	SCCWRP, 1975b
					0.22^{B}	Polychaete trochophore larvae, *Capitella capitata*	96-hr LC_{50}	Oshida, et al., 1976
					0.2^{B}	Oyster, *Crassostrea virginica*	Heavy mortality in 13 weeks	Oshida, et al., 1976
					0.17^{B}	Phytoplankton	Reduced photosynthesis	SCCWRP, 1975b
					0.12^{B}	Invertebrates	Decreased osmoregulation	SCCWRP, 1975b
					0.0^{ABCD}	Invertebrates	Delayed spawning in adults	SCCWRP, 1975b
Pb^{+2}	0.04	1.13	0.05	0.03	>10	Polychaete adult, *Neanthes arenaceodentata*	96-hr LC_{50}	Oshida, et al., 1976
					>7.5	Polychaete juvenile, *Neanthes arenaceodentata*	96-hr LC_{50}	Oshida, et al., 1976
					6.8	Polychaete adult, *Capitella capitata*	96-hr LC_{50}	Oshida, et al., 1976
					5.0	Invertebrates	Decreased growth	SCCWRP, 1975b
					3.9	Bay mussel, *Mytilus edulis*	Modified sublethal response	SCCWRP, 1973
					3.2	Polychaete adult, *Neanthes arenaceodentata*	28-day LC_{50}	Oshida, et al., 1976
					2.5	Polychaete juvenile, *Neanthes arenaceodentata*	28-day LC_{50}	Oshida, et al., 1976
					1.3	Polychaete, *Mercierella enigmatica*	Modified sublethal response	SCCWRP, 1973
					1.2	Polychaete trochophore larvae, *Capitella capitata*	96-hr LC_{50}	Oshida, et al., 1976
					1.0^{B}	Polychaete adult, *Capitella capitata*	28-day LC_{50}	Oshida. et al., 1976
					1.0^{B}	Polychaete, *Ophryotrocha labronica*	+600-hr LC_{50}	Oshida, et al., 1976
					1.0^{B}	Invertebrates	Induced morphological changes	SCCWRP, 1975b
					0.3^{B}	Protozoan, *Christigera*	Decreased growth 12%	Gray & Ventilla, 1973
					0.14^{B}	Isopod, *Sphaeroma pentodon*	Modified sublethal response	SCCWRP, 1973
Ni^{+2}	0.18	3.1	0.20	0.14	>330	European cockle, *Cardium edule*	48-hr LC_{50}	SCCWRP, 1973
					330-100	European brown shrimp, *Crangon crangon*	48-hr LC_{50}	SCCWRP, 1973
Fe^{+3}	0.64	78.8	0.69	0.33	330-100	European cockle, *Cardium edule*	48-hr LC_{50}	SCCWRP, 1973

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Table III-C-2 (Cont.)

CONSTITUENT	CONCENTRATION (mg/1 = ppm)					TAXA	EFFECT	REFERENCES
	A 5-MILE EFFLUENT[1]	B 7-MILE EFFLUENT[1]	C PRIMARY TREATMENT[2]	D SECONDARY TREATMENT[3]	BIOASSAY[4]			
Fe^{+3} (cont)	0.64	78.8	0.69	0.53	$100\text{-}33^{B}$	European brown shrimp, *Crangon crangon*	48-hr LC_{50}	SCCWRP, 1973
					32^{B}	Mussel embryo, *Mytilus*	Abnormal development	SCCWRP, 1973
					10^{B}	Urchin embryo, *Paracentrotus*	Abnormal development	SCCWRP, 1973
Mn^{+2}	0.02	$\overset{*}{0.19}$	0.02	0.03	32	Urchin embryo, *Paracentrotus*	Abnormal development	SCCWRP, 1973
					32	Mussel embryo, *Mytilus*	Abnormal development	SCCWRP, 1973

Note: There is uncertainty inherent in comparing discharged constituents with bioassay values. The effective concentration of each constituent is comparable between measured discharge level and bioassay level only if chemical assay techniques are identical. Moreover, toxicity values are valid only for those forms of constituents tested, and may not take into account the form and solubility the constituents may take in seawater. Thus, discharged constituents may not produce the indicated bioassay response, even when all other variables are considered equal.

[1] 1974 HTP effluent concentrations (SCCWRP, 1975a) reported as total chemical species of each constituent.

[2] Predicted effluent characteristics based on 1974 treatment reported as concentration for total chemical species of each constituent.

[3] Predicted effluent quality under full secondary treatment with UNOX (F. Hoeptner, personal communication, 23 December 1976) reported as concentration for total chemical species of each constituent.

[4] Concentration tested in bioassay for specified constituent form.

[5] No data for effluent concentrations.

[6] Total PCB's in effluent.

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Table III-C-3. Sublethal and lethal effects of wastewater constituents to marine fish. The concentrations discharged in the HTP 5-mile and 7-mile effluents are also given. Potential effects of the various effluent treatments are designated in the bioassay column by effluent column letter superscripts.

CONSTITUENT	CONCENTRATION (mg/l = ppm)					SPECIES	EFFECT	REFERENCES
	A 5-MILE EFFLUENT[1]	B 7-MILE EFFLUENT[1]	C PRIMARY TREATMENT[2]	D SECONDARY TREATMENT[3]	BIOASSAY[4]			
DDT	0.00072	0.00259	–[5]	–[5]	0.01^{B}	Killifish	Retarded fin regeneration	Weis & Weis, 1975
					50	American Eel	Decreased intestinal water absorption	Janicki & Kinter, 1971
					< 0.1	Grunion Fry	Increased pectoral fin ray asymmetry	Valentine & Soule, 1973
					0.1	Grunion Fry	Lethal	Valentine & Soule, 1973
					0.00053^{AB}	Striped Bass (small)	96-hour LC_{50}	EPA, 1975
					0.0026^{B}	Shiner Perch	96-hour LC_{50}	EPA, 1975
					0.00026^{AB}	Dwarf Perch	96-hour LC_{50}	EPA, 1975
					0.3-1.0	*Pleuronectes platessa*	48-hour LC_{50}	Portmann, 1970
Endosulfan	–[5]	–[5]	–[5]	–[5]	0.33-0.1	*Agonus cataphractus*	48-hour LC_{50}	Portmann, 1970
Azinphos-methyl (insecticide)	–[5]	–[5]	–[5]	–[5]	0.01-0.03	*Pleuronectes limanda*	48-hour LC_{50}	Portmann, 1970
PCB's	0.00038[6]	0.0033[6]	–[5]	–[5]	>10	*Agonus cataphractus*	48-hour LC_{50}	Portmann, 1970
Aroclor 1248					>10	*Agonus cataphractus*	48-hour LC_{50}	Portmann, 1970
Aroclor 1254					>10	*Agonus cataphractus*	48-hour LC_{50}	Portmann, 1970
Aroclor 1260					>10	*Agonus cataphractus*	48-hour LC_{50}	Portmann, 1970
Clophen A30					>10	*Agonus cataphractus*	48-hour LC_{50}	Portmann, 1970
Clophen A60								
Hg^{+2}	0.0032	0.154	0.0041	0.0011	0.230	Killifish	Decreased liver acid phosphatase, RNAase, xanthine oxidase and catalase activity	Jackim, et al., 1970
							Increased liver alkaline phosphatase activity	Jackim, et al., 1970
					0.02^{B}	Killifish	Reduced liver and kidney δ-amino levalinic acid dehydrogenase activity	Jackim, 1973
					3.3	*Pleuronectes flesus*	48-hour LC_{50}	Portmann, 1970
Ag^{+1}	0.02	0.04	0.03	0.019	0.04^{B}	Killifish	Decreased liver alkaline phosphatase, xanthine oxidase, catalase and RNAase activity	Jackim, et al., 1970
					0.02^{ABC}	Killifish	Increased liver δ aminolevalinic acid dehydrogenase activity	Jackim, 1973
Zn^{+2}	0.24	23.9	0.34	0.23	10^{B}	Killifish	Reduced liver δ aminolevalinic acid dehydrogenase activity	Jackim, 1973
Ammonia	13.8	228	15.8	15	1.2^{ABCD}	Dogfish	Lethal in 193 minutes	Becker & Thatcher, 1973
Detergents	5.1	–[5]	7.7	1.27	>10	*Pleuronectes flesus*	48-hour LC_{50}	Portmann, 1970
Phenol	0.06	–[5]	0.06	0.02	33-100	*Pleuronectes flesus*	48-hour LC_{50}	Portmann, 1970
Cu^{+2}	0.19	13.9	0.22	0.11	0.180^{ABC}	Winter Flounder	Increase in chloride cells with a decrease in mucus cells in gills	Baker, 1969
							Vacuolation of gill epithelial cells	
					1.0^{B}	Winter Flounder	Fatty metamorphosis of liver	Baker, 1969
							Renal necrosis	
							Gross changes in gill structure	
					3.2^{B}	Winter Flounder	Complete cell destruction in gills	Baker, 1969
					0.5^{B}	Killifish & Atlantic Silversides	Lesions in olfactory and lateral line sensory organs	Gardner & LaRoche, 1973
					1.0^{B}	Killifish	Renal lesions	Gardner & LaRoche, 1973
					0.25^{B}	Killifish Zygotes	Reduced survival after hatching by 45 percent	Gardner & LaRoche, 1973
					3.0^{B}	Killifish Zygotes	No hatching	Gardner & LaRoche, 1973
					2.1^{B}	Killifish Larvae	24-hour LC_{50}	Gardner & LaRoche, 1973
					1.2^{B}	Killifish Larvae	48-hour LC_{50}	Gardner & LaRoche, 1973
					1.0^{B}	Killifish Larvae	72-hour LC_{50}	Gardner & LaRoche, 1973
					$1\text{-}3.3^{B}$	*Pleuronectes flesus*	48-hour LC_{50}	Portmann, 1970
					3.2^{B}	Killifish	Decreased liver catalase, RNAase, and acid phosphatase activity	Jackim, et al., 1970
							Increased liver xanthine oxidase activity	
Cr^{+6}	0.0	0.0	0.0	0.0	15	Speckled Sanddab	Decreased feeding in 4 days	SCCWRP, 1975a
					3.7	Speckled Sanddab	Decreased feeding in 14 days	SCCWRP, 1975a
					2.2	Speckled Sanddab	Decreased feeding in 21 days	SCCWRP, 1975a
					31.0	Speckled Sanddab	4-day LC_{50}	SCCWRP, 1975a
					5.4	Speckled Sanddab	21-day LC_{50}	SCCWRP, 1975a
					33-100	*Agonus cataphractus*	48-hour LC_{50}	Portmann, 1970
Cd^{+2}	0.02	1.27	0.03	0.02	27	Killifish	Decreased liver acid phosphatase, xanthine oxidase, catalase and RNAase activity	Jackim, et al., 1970
Pb^{+2}	0.04	1.13	0.05	0.03	188	Killifish	Decreased liver acid phosphatase, xanthine oxidase, catalase and RNAase activity	Jackim, et al., 1970
							Increased liver alkaline phosphatase activity	
					10	Winter Flounder and Killifish	Reduced liver and kidney δ-aminolevalinic acid dehydrogenase activity	Jackim, 1973

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[1] 1974 HTP effluent concentrations (SCCWRP, 1975a) reported as total chemical species of each constituent.

[2] Predicted effluent characteristics based on 1974 treatment reported as concentration for total chemical species of each constituent.

[3] Predicted effluent quality under full secondary treatment with UNOX (Hoeptner, 23 December 1976) reported as concentration for total chemical species of each constituent. The ammonia concentration is based on an influent of 17 mg/l and no removal by the treatment process.

[4] Concentration tested in bioassay for specified constituent form.

[5] No data for effluent concentrations.

[6] Total PCBs in effluent.

sections. The potential effects predicted from data in these tables must be evaluated recognizing that the predictions are based on undiluted effluent. The HTP effluent, however, is diluted by mixing with seawater, but may still be toxic to some organisms near the discharge point. Second order (indirect) toxicity may also occur through biomagnification in the food web. This section is organized by biological category: phytoplankton, zooplankton, benthos (benthic invertebrates and plants), nektonic (free-swimming) invertebrates, fish, birds, and mammals. The results of the studies conducted in the vicinity of the Hyperion outfalls appear under the appropriate category.

Extensive and fairly comprehensive species lists including data from a number of sources have been compiled for this report and appear in Appendix III.B. They list organisms by habitat type or by sampling location and are useful in determining the species likely to be influenced by discharges from sewage treatment plants.

a. Bacteria and Viruses.

(1) DISTRIBUTION AND ABUNDANCES OF BACTERIA AND VIRUSES. Ocean waters contain many naturally occurring bacteria. The concentrations of marine and freshwater bacteria in the water column and sediments at the HTP outfalls and at two non-outfall areas (Santa Monica Basin and Dana Point) are shown in Table III-C-4. The sediments generally contain one to two orders of magnitude more bacteria than the water column.

Table III-C-4. Concentrations (cells/ml) of total marine and freshwater aerobic and anaerobic bacteria in water and sediment samples from Dana Point, Santa Monica Basin, and Santa Monica Bay (SCCWRP, 1975a).

LOCATION	NON-OUTFALL AREAS		HYPERION 5- AND 7-MILE OUTFALL AREA, SANTA MONICA BAY
	DANA POINT	SANTA MONICA BASIN	
Surface Water			
Marine aerobes	770	773	360
Freshwater aerobes	390	390	328
Midwater			
Marine aerobes	130	-	423
Freshwater aerobes	10	-	760
Sediment			
Marine aerobes	50,000	7,200	13,266
Freshwater aerobes	12,600	72,000	49,000
Marine anaerobes	20,800	8,800	2,475
Freshwater anaerobes	2,100	2,800	6,850

(2) PATHOGENIC EFFECTS OF BACTERIA AND VIRUSES FROM WASTEWATER OUTFALLS. The pathogenic bacteria and viruses discharged in any wastewater discharge constitute a potential public health hazard, although no epidemiology exists to show a problem is or will be present as a result of the HTP outfalls. The pathways of infection in humans are through recreational use of contaminated waters and through eating shellfish that have concentrated the microorganisms (Cabelli et al., 1975). On both the east and west coasts of the United States, beaches and shellfish beds have been closed periodically because of microbial contamination.

The pathogenic bacteria and fungi of most concern are *Salmonella typhimurium, Candida albicans*, and *Staphylococcus aureus*, and the potentially pathogenic viruses are poliovirus, coxsackie virus, echovirus, and hepatitis virus. Wastewater also contains other bacteria such as coliforms and fecal streptococci. These other bacteria are used as indicators of the pathogenic ones above since they are easier to test for and occur in higher concentrations. In water pollution studies, fecal streptococci are better indicators of enteric viral pollution than total coliform or fecal coliform bacteria since their survival is similar to that of the viruses (Cohen and Shuval, 1973).

The survival rates of each type of bacteria in seawater are generally unknown, but may be quite different for each species. Most coliform bacteria do not survive for more than two weeks, and sunlight kills these bacteria in the surface waters to a depth of as much as 3 m (Vind et al., 1975). In addition, coliform mortality rate increases with increasing hydrostatic pressure (Dresnack and Chack, 1973), and temperature is also a controlling factor. At 3-4 C (38-40 F) the survival of *E. coli* is enhanced in polluted seawater while at higher temperatures growth occurs resulting in an approximately forty-fold population increase with persistence for at least 18 weeks (Won and Ross, 1973). Predation by other marine microorganisms is another factor influencing bacterial survival; however, low concentrations of chlorinated hydrocarbons cause a reduction in predation on intestinal bacteria (*E. coli*) as a result of blockage of the predator's chemostatic response for spatial location of prey (Mitchell et al., 1973).

Another public health concern related to wastewater bacteria is the drug resistance found naturally in enterobacteria. This bacteria drug resistance has been found not only in humans, but also in domestic animals, fish, river water receiving sewage (Davies and Rownd, 1972), and sewage sludge in the New York Bight (Koditschek and Guyre, 1974). The resistance is produced by an extrachromosomal genetic element, called an R factor, that can be transferred by conjugation or transduction to bacteria of different species. Thus far, resistance has been found for at least ten antibiotics as well as several other antimicrobials, such as heavy metals (Davies and Rownd, 1972). Multiple resistance also occurs, although all of the resistance determinants are not known to occur simultaneously in one R factor isolated from nature.

The R factor transmission from sewage (wastewater or sludge) to humans occurs via ingestion of contaminated water or poorly cooked fish and shellfish. The R factor is then transferred to the normal resident flora in the intestine which maintains it. Pathogens, such as *Salmonella* or *Shigella,* entering the body may subsequently receive the R factor from these bacteria, thus becoming resistant to the drugs used for treatment of the disease caused by these organisms (SWRCB, 1975).

Viruses are not easily measured in sediments, and their concentrations in the ocean around outfalls are unknown but are apparently 3 to 6 times as long as those for coliform bacteria (SCCWRP, 1976). Viral survival rates in seawater are also not well known. Viruses readily adsorb to suspended particulates, and this association with solids enhances their survival (Gerba and Schaiberger, 1975). Thus, viruses may be accumulated in the sediments. Increases in the organic content of the sediments or a reduction in salinity can cause the viruses to dissociate from the solids (Gerba and Schaiberger, 1975). An item of public health concern is that enteroviruses are infectious whether they are eluted from particulates or adsorbed (Stagg, 23 April 1976), and shellfish are efficient concentrators of viruses (SCCWRP, 1976).

b. Phytoplankton.

(1) DISTRIBUTION, ABUNDANCE, AND PRODUCTIVITY OF PHYTOPLANKTON. The phytoplankton, primary producers forming the base of the aquatic food web, comprise:

- Chrysophytes (diatoms, coccolithophores, and silicoflagellates),
- Pyrrhophytes (dinoflagellates),
- Euglenophytes (euglenoids),
- Chlorophytes (green algae), and
- Cyanophytes (blue-green algae)

of which only the chrysophytes and pyrrhophytes have been studied extensively in the Southern California Bight. Approximately 160 taxa have been identified, the most common of which are listed in Appendix III.B. These are relatively small plankton ranging from 10 to 50 μm in diameter, too small to be captured by the usual zooplankton sampling nets.

The composition of the phytoplankton community varies seasonally (Figure III-C-2). The dominant diatoms occurring in the coastal Southern California Bight between 1957 and 1959 were *Chaetoceros* spp., and the dominant dinoflagellate was *Prorocentrum micans* (BLM, 1975). Reid et al. (1970) found that near-shore to La Jolla, phytoplankton were dominated by *Peridinium depressum* and other pyrrhophytes, except during upwelling. Densities of some phytoplankton taxa decrease with depth while those of others reach a maximum at about 30 meters. The distribution of phytoplankton appears to be relatively uniform within the Bight because currents tend to mix shelf waters, but near large sewage outfalls the percentage of diatoms in the phytoplankton assemblage is higher than away from outfalls (Allan Hancock Foundation, 1959 and 1965). Alterations of species composition and abundance near outfalls are probably attributable to availability of nutrients. Changes in species composition of the diatom and dinoflagellate community in surface waters occurred near the Hyperion outfalls between 1957 and 1970 when the discharge was changed from the 1-mile outfall in 14 to 18 meters of water to the 5-mile outfall at a depth of 60 meters (SCCWRP, 1973). It is probable that the increased depth of the outfall resulted in decreased amounts of sewage nutrients reaching the phytoplankton community even though the effluent quantity increased from 260 to 340 mgd. During this period, two diatoms, *Chaetoceros* and *Dactyliosolen*, increased in relative dominance while the diatoms, *Ditylum* and *Achnanthes*, decreased. Of the dinoflagellates, *Noctiluca* increased and *Ceratium* decreased (SCCWRP, 1973).

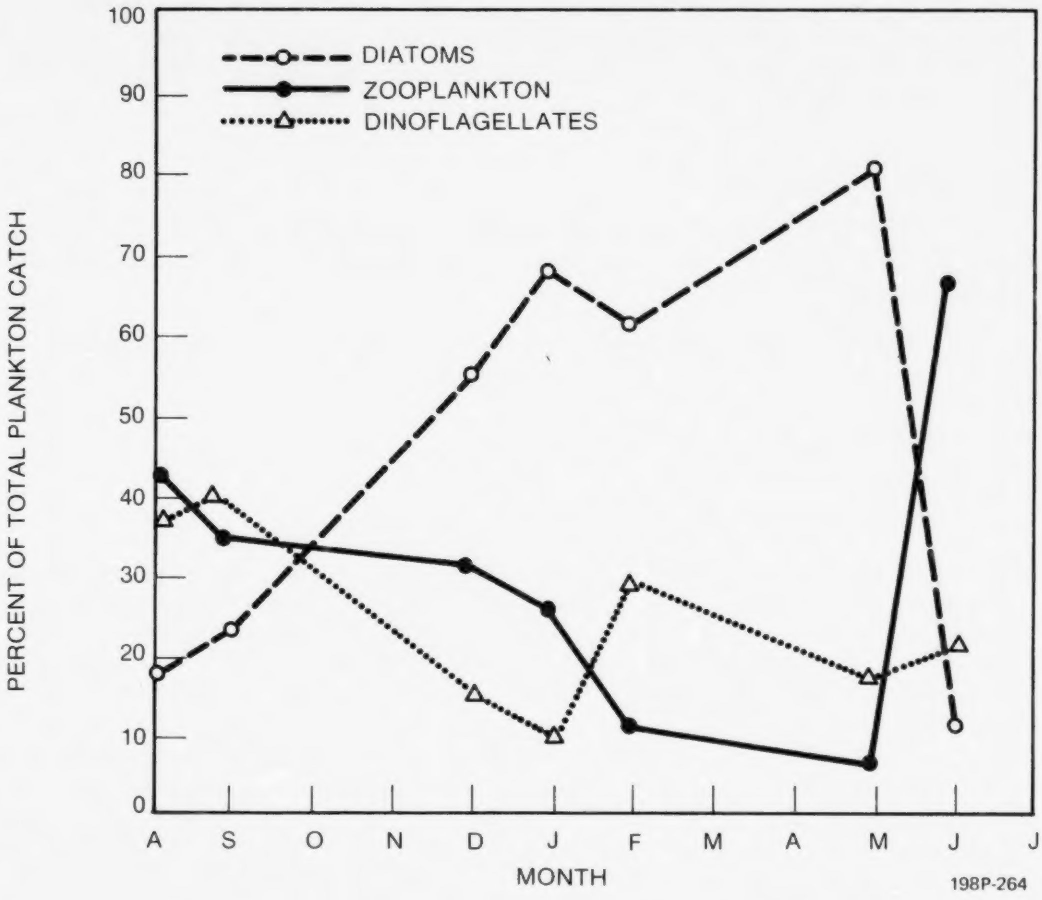

Figure III-C-2. Relative composition of plankton tows from August 1955 to July 1956 off the southern California mainland shelf. Diatoms and dinoflagellates are the most abundant groups of the phytoplankton community (modified from BLM, 1975 after Allan Hancock Foundation, 1965).

When the Point Loma (San Diego) Sewage Treatment Plant outfall was put into operation, the density of the dinoflagellate, *Noctiluca,* decreased, but the density of the dinoflagellates, *Dinophysis, Prorocentrum,* and *Oxytoxum,* and diatoms, *Skeletonema* and *Mastogloia,* all increased. *Gonyaulax*, the dinoflagellate responsible for most red tides in the San Diego area, was abundant both before and during the operation of the Point Loma Plant (Marine Advisors, 1963; Water Resources Engineers, 1965).

The potential enhancement of red tide phytoplankton blooms by the nutrients in sewage effluent has been an item of concern, but it is unlikely that sewage effluent triggers red tides. There is a long history of red tides in the Southern California Bight predating any human-related nutrient additions (Clendenning, 1958), and red tides usually occur after a decline (rather than an increase) in organic carbon and phosphates when ocean nutrients are extremely low. Red tide blooms usually follow diatom blooms caused by natural upwelling (May, 1976) and utilize most of the nutrients released from decomposition of the dead diatoms. Thus, high concentrations of dissolved nutrients may not be observed during the phase of rapid reproduction in dinoflagellates. Blooms of these water-discoloring dinoflagellates may cause fish kills indirectly as a result of low oxygen conditions produced by bacterial decomposition when the dinoflagellates die in large numbers and directly as a result of the bio-accumulation in fish of the neurotoxin produced by the dinoflagellates, although this latter theory has not been adequately substantiated. The reduced water circulation caused by man-made harbors such as Los Angeles-Long Beach Harbor tend to enhance stagnant conditions caused by red-tide blooms and increase the likelihood of fish kills.

Gonyaulax polyhedra, Prorocentrum micans, and an unidentified dinoflagellate have caused most of the red tides from 1924 to 1945 in San Diego Bay (Allen, 1933, 1935, 1938, 1940, 1942, 1943, and 1946). *G. polyhedra* seems to cause late summer red tide outbreaks, while *P. micans* may be associated with spring blooms. Other genera responsible for red tides at La Jolla include *Gymnodium* and *Cocholdinium.* The dinoflagellate associated with red tides in Mission Bay (1961) was *Gymnodinium flavum* (Lackey and Clendenning, 1963) and at Santa Monica Bay (1945) was *Polykrikos schwartzii* (Brongersma-Sanders, 1957). *Gonyaulax catenella* has been found to cause red tides north of Point Conception.

Studies of phytoplankton species composition and abundance have been made in greatest detail in San Diego and Mission Bays, and it is likely that species of the same genera occur in Los Angeles Harbor. Species compositions, however, are not necessarily similar, even in adjacent bays. Lackey (1967) found 57 species of dinoflagellates in San Diego Bay and 49 species in Mission Bay with only 25 species in common, even though the bays are adjacent to each other on the southern California coast. Twenty-six genera of diatoms have been collected by Fairbanks (1969) from the two bays. Major diatom genera were *Thalassiosira, Asterionella, Skeletonema, Coscinodiscus, Nitzchia, Navicula, Thalassiothrix,* and *Grammatophora,* and major dinoflagellates were *Dinophysis, Prorocentrum,* *Peridinium, Ceratium,* and *Gonyaulax.* Diatoms appeared to be more abundant at the inner part of San Diego Bay, while the opposite was true for dinoflagellates (Lackey and Clendenning, 1965).

Other phytoplankton groups found in coastal embayments are Volvocales, Chlorophycae, Euglenophycae, Cryptophycae, and Chrysophycae. Volvocales are represented by nine species in San Diego Bay. Blooms of Chlorococcales, which do not commonly occur in marine waters, were recorded 26 times in San Diego Bay in the summer of 1959. Most Euglenophycae are found in both plankton and benthos and are usually more abundant than the green algae in bays. Of the 34 species of Euglenophycae collected in benthic samples, nine have been found in San Diego Bay phytoplankton samples. *Eutreptia lanowii* (a Euglenophycae) produced one bloom in San Diego Bay in 1959. Five genera of Cryptophycae, the most widespread of phytoplankters, are usually important in bays: *Chilomomas, Chroomonas, Cryptomonas, Cyathomonas,* and *Rhodomonas.* Twelve blooms of these phytoplankters were observed in San Diego Bay in 1959. Five of the 23 species of Chrysophycae caused nine blooms in the summer of 1959 in San Diego Bay (Lackey, 1967; Lackey and Clendenning, 1965).

Phytoplankton biomass and primary productivity are relatively high along the coast of California because of upwelling of nutrient-rich water. These upwelled nutrients originate from decomposition of organic material in the water column and sediments.

Eppley et al. (1972) compared chlorophyll *a* concentrations (a measure of phytoplankton biomass)(Figure III-C-3) and primary productivity (Table III-C-5 and Figure III-C-4) in the vicinity of the JWPCP (Whites Point, Los Angeles County) and Point Loma (San Diego) sewage outfalls with a non-outfall area in Scripps Canyon off La Jolla. Both biomass and primary productivity were much higher near the outfalls.

In another study of the Point Loma and JWPCP outfalls, phytoplankton productivity and chlorophyll was not clearly increased as compared with a control area near La Jolla, although subsurface ammonium levels were higher at the outfalls than at the control location (IMR, 1971 in Thomas, 1972). It was suggested that the abundant subsurface ammonium near the outfalls had not yet been assimilated by the surface phytoplankton.

In yet another study of the Point Loma, JWPCP, and HTP outfalls, Thomas (1972) found that eutrophication was evident in surface waters only in the summer at Point Loma; in the summer, fall, and winter at HTP; and all year at the JWPCP outfalls. Increases in chlorophyll concentrations over those measured at a control location offshore from Camp Pendleton (that were significant below the 0.05 probability level by the Mann-Whitney nonparametric "U" test) were used as an indicator of eutrophication. Moreover, this eutrophication was observed to extend 2 to 5 miles from the discharge point for both the JWPCP and HTP outfalls and one mile from the Point Loma outfall. These results indicate that phytoplankton standing crop (as measured by chlorophyll) may not always show eutrophication in the vicinity of sewage outfalls. The amount of sewage discharged, the depth of the discharge, the strength and depth of the thermocline,

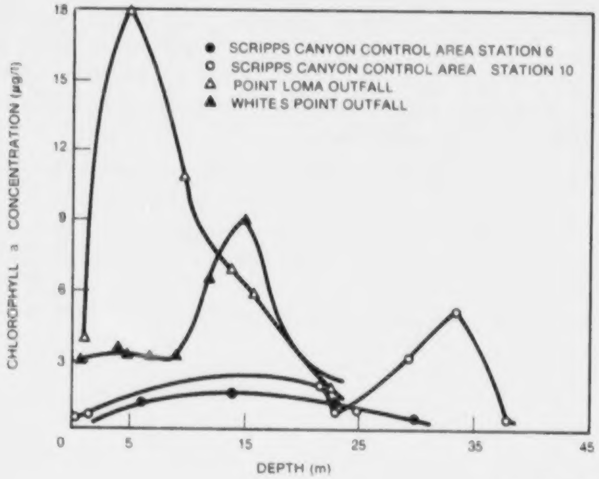

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Figure III-C-3. Concentrations of chlorophyll near sewage outfalls and in control areas (after Eppley et al., 1972).

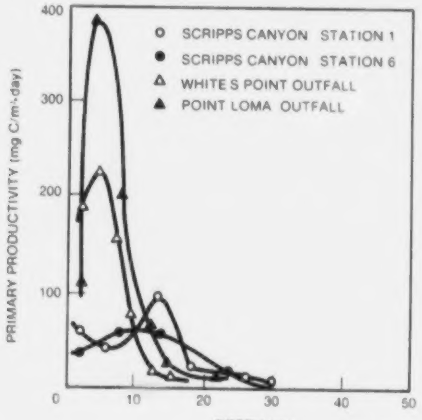

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Figure III-C-4. Primary productivity near sewage outfalls and in control areas (after Eppley et al., 1972).

NOTE: These figures show that phytoplankton abundance and primary productivity can be directly enhanced by sewage treatment plant effluent. Whether such enhancement occurs in the vicinity of the Hyperion Treatment Plant outfalls has not been examined in the past six years.

Table III-C-5. Comparison of phytoplankton standing crop and primary productivity, integrated over the depth of the euphotic zone, for stations near the Point Loma (San Diego) and Whites Point (Los Angeles County) sewage outfalls, and near Scripps Canyon where there is no outfall (after Eppley et al., 1972).

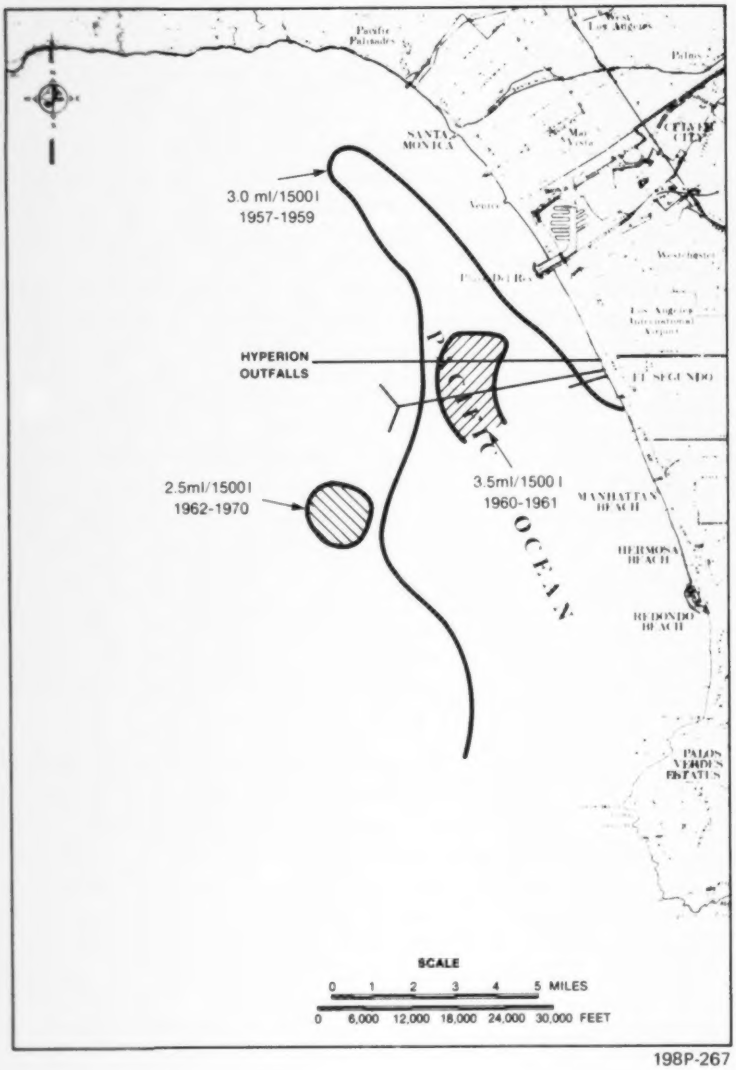
PARAMETER	STATION		
	PT. LOMA OUTFALL	WHITES PT. OUTFALL	SCRIPPS CANYON[1] (NO OUTFALL)
Phytoplankton carbon (g/m^2)(as 250 x ATP)	12.1	5.9	5.5
Chlorophyll a (mg/m^2)	163	83	33
Primary production ($g\ C/m^2 \cdot day$)	2.64	1.76	0.94
Specific growth rate (doubling/day)	0.28	0.37	0.24
Depth of euphotic zone (m)	21	16.5	37

[1] Mean of three stations.

NOTE: This table shows that phytoplankton abundance and productivity near sewage treatment plant outfalls are increased over the levels in control areas.

and the prevalence of localized upwelling may interact to supply or limit nutrients that surface phytoplankton need to proliferate. Furthermore, Thomas (1972) postulated that the discharge of certain toxicants in sewage may result in a lower phytoplankton standing crop than expected based on the nutrients present from the sewage.

In Santa Monica Bay during the period 1957 through 1961 when the Hyperion Treatment Plant was discharging effluent through its 1-mile shallow outfall, the highest plankton standing crops (zooplankton and phytoplankton combined) occurred near the outfall (Figure III-C-5). When some of the discharge volume was switched to the 5-mile (60 meters deep) outfall in 1960, the area of higher plankton concentration moved offshore. After 1962, when all wastewater was discharged through the 5-mile outfall, plankton decreased generally throughout the Bay. This decreased productivity is expected because nutrients from deep outfalls are limited in their transfer to the euphotic (light) zone where phytoplankton live. Taxonomic data for the samples collected from 1957 through 1970 is available at HTP but is presently unanalyzed.



Pacific Palisades
West Los Angeles
Palms
SANTA MONICA
Culver City
Mar Vista
Venice
Westchester
Playa Del Rey
Los Angeles International Airport
3.0 ml/1500 l
1957-1959
HYPERION
OUTFALLS
EL SEGUNDO
PACIFIC OCEAN
3.5ml/1500 l
1960-1961
2.5ml/1500 l
1962-1970
MANHATTAN BEACH
HERMOSA BEACH
REDONDO BEACH
PALOS VERDES ESTATES
SCALE
0 1 2 3 4 5 MILES
0 6,000 12,000 18,000 24,000 30,000 FEET

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Figure III-C-5. Maximum plankton concentrations (biovolume) during three sampling periods. Effluent was discharged from the HTP 1-mile outfall until 1962 and from the 5-mile outfall beginning in 1960. During and after changeover to the 5-mile outfall, the zone of highest plankton density moved offshore and decreased (from SCCWRP, 1973).

The phytoplankton populations of enclosed bays such as San Pedro Bay, Alamitos Bay, San Diego Bay, and Mission Bay can be greatly increased by nutrients from sewage effluent. When municipal and industrial wastes were dumped directly into San Diego Bay before 1963, phytoplankton blooms occurred continuously throughout the summer (Sweeney and Clendenning, 1958) but no longer do so since the discharge was changed to a deep ocean outfall.

In Los Angeles Harbor, which is enriched by nutrients from the Terminal Island Treatment Plant outfall (averages 10.3 mgd with a BOD_5 of 160 mg/l; ESI, 1971) as well as by nutrients from a number of industrial (fish cannery discharges average 2.2 mgd with a BOD_5 of 975 mg/l; ESI, 1971) and non-point sources, productivity reached values of 250 mg $C/m^3 \cdot hr$ in midsummer 1971 and remained below 160 mg $C/m^3 \cdot hr$ in the summers of 1972 and 1973. During the other seasons, the productivity rarely exceeded 50 mg $C/m^3 \cdot hr$ (Oguri, 1974). Immediately adjacent to the Terminal Island Treatment Plant and fish cannery discharges the phytoplankton productivity and chlorophyll *a* levels were generally depressed throughout the year by 10 to 90 percent as compared to other stations located in Los Angeles Harbor. Outside the breakwaters the productivity ranged from 0.7 to 56.6 mg $C/m^3 \cdot hr$. These values are somewhat higher than the 1 to 12 mg $C/m^3 \cdot hr$ average observed in the open ocean (eastern part of the Santa Barbara Basin; Straughan, 1971) but only half as high as values observed by Eppley et al. (1972) near the Point Loma Outfall (Figure III-C-3). Chlorophyll *a* concentrations in Los Angeles Harbor reached maximum levels of 10 $\mu g/m^3$ during 1971-1972 (Dames & Moore, 1973) which is about the same as those observed by Eppley et al. (1972) near the Whites Point outfall and half as high as values observed near the Point Loma outfall (Figure III-C-4).

(2) UPTAKE, BIOACCUMULATION, AND TOXICITY OF POLLUTANTS IN PHYTOPLANKTON. Phytoplankton concentrate metals and chlorinated hydrocarbons from sea water (Waldichuk, 1974), consequently providing a concentrated source of the toxicants to organisms higher in the food web. Aubert et al. (1972) described the accumulation of certain metals in phytoplankton as Pb>Cu>Hg>Zn>Cr, with humic acids and sewage depressing the accumulation of copper and lead while enhancing the bioaccumulation of zinc and chromium. The diatom, *Synedra ulna,* took up mercury from surrounding water, attaining the maximum level in the first 6 hours (Fugita and Hashizume, 1975). About half of this mercury was incorporated intra-cellularly and could not be eliminated by elution. Only mercuric chloride that was freely dissolved into the culture medium and filterable, rather than precipitated or adsorbed to particulates, was taken up by *S. ulna* (Fugita and Hashizume, 1975). Davies (1974) observed that the dinoflagellate, *Isochrysis galbana,* concentrated mercury to 2 g/l intracellularly before growth was stopped. Pesticides (DDT and dieldrin) are also taken up rapidly by marine phytoplankton (Rice and Sikka, 1973 a&b). Differential amounts of DDT are concentrated, always to levels much higher than the surrounding water, by the phytoplankton (in descending order of concentrating ability): *Skeletonema costatum* > *Cyclotella nana* >

Isochrysis galbana > *Olisthodiscus luteus* > *Amphidinium carteri* > *Tetraselmis chuii*. The latter algae degraded 12 percent of the DDT taken up to DDE in 12 days, while the others converted lesser percentages (Rice and Sikka, 1973b). PCB's are also accumulated in marine phytoplankton (Giam et al., 1973).

Toxicity of various substances to phytoplankton is reported in Table III-C-2. These toxic and sublethal levels pertain to "normal" temperature and salinity conditions, whereas increased temperature in the case of *Rhizosolenia setigera* increased the toxicity of PCB's (Fisher and Wurster, 1973). Furthermore, there are geographical differences in the tolerance of phytoplankton to toxic substances. Coastal and estuarine phytoplankton, *Fragilaria pinnata, Thalassiosira pseudonana,* and *Bellerochia* sp., were found to tolerate higher concentrations of PCB's than their oceanic counterparts (Fisher et al., 1973). The concentrations of toxic constituents in the HTP effluent and sludge and their potential effects are also presented in Table III-C-2.

When present together in sea water, DDT, DDE, and PCB's interact in various modes to alter their toxicity to diatoms (Mosser et al., 1974). DDE was found to interact synergistically with PCB's. For instance, diatom growth was negligibly inhibited by 10 ppb PCB's or 100 ppb DDE, whereas a mixture of these substances in the same concentrations inhibited growth substantially. DDT, however, counteracted the toxicity of PCB's; that is, treatment of diatom cultures with 50 ppb PCB's almost stopped growth, but simultaneous treatment with 50 ppb PCB's and 500 ppb DDT restored the growth rate to about two-thirds of that in control cultures. Moreover, DDT added 12 or 24 hours after PCB treatment also reversed inhibition by PCB's. Interaction between DDT and DDE was found to be slight (Mosser et al., 1974). DDT and PCB's occurring separately in the ocean reduce cell division rate of phytoplankton and thereby indirectly reduce total photosynthetic carbon fixation. The photosynthetic capacity of individual phytoplankton cells, however, are not affected. Thus, total marine photosynthesis may remain undiminished by these compounds, although selective alterations in the phytoplanktonic community through selective toxicity could affect herbivore populations (Fisher, 1975). Pesticides have also been found to increase antibiotic activity in diatoms (Aubert et al., 1972).

c. Zooplankton.

(1) DISTRIBUTION, ABUNDANCE, AND PRODUCTIVITY OF ZOOPLANKTON. Most studies of zooplankton have emphasized distribution in the open ocean or in bays and little is known about the distribution and abundance of near-shore (5 to 10 nautical miles from shore) zooplankton species along the California coast.

It is known that the species composition of zooplankton communities of the near-shore region differs from that in the ocean by having a higher proportion of larval forms of organisms that may or may not be planktonic as adults (meroplankton) and by having higher densities of some true plankton (holoplankton) species, particularly copepods. The species characteristic of the near-shore region generally have peak abundances 1.6 to 3.2 km from shore, grading to low densities 16 to 32 km out (Hedgpeth, 1973). Comprehensive data on zooplankton species distribution and abundance are difficult to gather because zooplankton are characteristically distributed in patches, and the organisms usually migrate vertically in the water column. Zooplankton that have been collected in the Southern California Bight are listed in Appendix III.B.

The most abundant zooplankton are the crustaceans which comprise copepods, cladocerans, amphipods, decapods, and euphausids. Dominant near-shore copepods include *Acartia tonsa, A. clausii, Paracalanus parvis, Labidocera trispinosa, Rhincalanus nasutus, Oithona similis, Oncaea conifera,* and *Corycaeus anglicus* (BLM, 1975). Dominant, near-shore cladocerans include *Evadne nordmanni, Podon polyphemoides,* and *Penilia avirostris* (BLM, 1975).

Amphipods are mostly benthic, although a few truly pelagic taxa have been studied by Bowman (1953) and Brusca (1967), and of these the genus *Hyperia* and the species *Vibilia armatus* appear to be most common.

Euphausids, shrimp-like crustaceans often known as krill, are part of the plankton community as larvae, but are too large and strongly-swimming to be considered planktonic in their adult stage. These organisms are widely distributed, and separate taxonomic groups are associated with various depths of water. They feed mainly on phytoplankton and sometimes are abundant at sites of upwelling. The dominant species are *Euphausia pacifica, Nematoscelis difficilis,* and *Nyctiphanes simplex;* and the less dominant species are *Stylocheiron longicorne, Thysanoessa gregaria,* and *T. spirifera* (Brinton, 1967; Seapy, 1974).

Larval stages of many decapod crustaceans are planktonic, while adults are usually either benthic or nektonic. In Anaheim Bay, Sowby (1973) collected high numbers of *Callianassa* sp. and *Pinnixa franciscana* zoea (meroplankton) throughout the year.

In addition to holoplanktonic and meroplanktonic crustaceans, the zooplankton community often includes primitive chordates, molluscs, chaetognaths, polychaetes, coelenterates, and ctenophores. The primitive chordates that sometimes numerically dominate the zooplankton in the epipelagic zone include salps and doliolids, especially in the summer when water temperatures exceed 14 to 15 C (McGinnis, 1971). Salps common in the Southern California Bight include *Cyclosalpa baheri, Pegea confoederata, Salpa fusiformis,* and *Thalia democratica.* The most common doliolids are *Dolioletta gegenbauri* and *Doliolum identiculatum* (Berner, 1968). Also, the larvacean, *Oikopleura* spp., is commonly found along the entire coast of California.

The groups of pelagic molluscs that have been collected from the Southern California Bight include cephalopods (squid and related species) and two free-swimming groups of gastropods (pteropods or sea butterflies and the heteropods). Cephalopods are nektonic and thus are discussed in Section III.C.2.d. The most common pteropod mollusc is *Limacina helicina* (McGowan, 1967), and the heteropods (gastropods with greatly reduced external shell) most commonly collected by Dales (1953) and McGowan (1967) were *Atlanta peroni, Atlanta* sp., and larval *Carinaria japonica*.

Chaetognaths (arrow-worms) have been collected in several studies of both near and off-shore waters. Off-shore and in-shore studies by Alvarino (1965) found *Sagitta euneritica, S. bierii, S. minima,* and *S. enflata* most abundant, with no evidence of seasonality or of species composition gradients with respect to the shore. SCE (1973) and Felts (1973) found *Sagitta euneritica* in high numbers year-round at two near-shore locations.

Pelagic polychaetes (segmented worms) are commonly collected in low densities (less than 20 organisms per 1,000 m^3)(BLM, 1975). Most of those that might occur in the water column in the Southern California Bight are listed in Appendix III.B. The most abundant were *Tomopteris elegans* and *T. septentrionales* (Dales, 1957). In addition, *Vanadis formosa* was collected by Seapy (BLM, 1975). There are also several general reports of polychaete larvae along the California coast (Icanberry and Adams, 1974; Dames & Moore, 1973; SCE, 1973). Polychaete larvae sometimes reach very high densities for a few days and nights in early spring in areas of normally low density.

The final major groups of zooplankton are the hydrozoan medusae and siphonophores of the phylum Coelenterata and "combjellies" of the phylum Ctenophora. Hydrozoans collected by Icanberry and Adams (1974), SCE (1973), and reported by Dames & Moore (1973) were not identified, except for *Obelia* sp., in the latter report. One species of Ctenophora, *Pleurobrachia bachei,* has been collected south of the Southern California Bight as deep as 525 meters and has occurred in densities of less than 50 individuals per 10,000 m^3 in the upper 100 meters of the water column (Alvarino, 1967).

Other groups from phyla less abundant in zooplankton collections, but which are found near-shore include the cyphonautes larvae of ectoprocts, peanut worm larvae (Sipunculida), flatworm larvae and adults (Platyhelmenthes), sea spiders (Pycnogonida), echinoderm larvae (bipinaria, echinopluteus, juvenile ophiuroids), and fish larvae (Icanberry and Adams, 1974; SCE, 1973).

Most taxa of major phyla discussed above also contribute meroplanktonic stages to the near-shore water column. Ostracod crustaceans and barnacle larvae are often present, and in addition, protozoans such as Foraminifera, Radiolaria, and Tintinnida may be collected as microzooplankton. Lackey (1967) found 41 species of ciliate protozoa in San Diego Bay and 23 species in Mission Bay, only four of which occurred in both bays although the entrances to the bays are only 11 km apart.

Zooplankton displacement volumes of samples collected in the Southern California Bight between 1951 and 1966 ranged from 64 to 256 ml/1,000 m^3 during February to July and from 16 to 64 ml/1,000 m^3 during October to January (Straughan, 1971). The only site-specific information on zooplankton biovolumes collected from 1957 through 1970 near the HTP outfalls in Santa Monica Bay is described in the phytoplankton section III.C.2.b. above and shown on Figure III-C-5 since near-shore sampling gear collected both phytoplankton and zooplankton simultaneously. The taxonomic data for these samples are presently unanalyzed. Zooplankton settling volumes (biomass) ranging from 0.01 to 6.09 ml/m^3 for organisms filtered through 253 μm mesh netting have been reported for San Pedro Bay in 1971 and 1972 (Dames & Moore, 1973). The highest values occurred at a station adjacent to and between the outfalls from the Terminal Island Sewage Treatment Plant and a large fish cannery. Annual mean zooplankton biomass (biovolume) has been reported by Howey (1971) to be 0.45 ml/m^3 for Anaheim Bay, which is about 2 to 6 times that found for off-shore zooplankton. Lowest seasonal values occur in winter and the highest in summer.

(2) UPTAKE, BIOACCUMULATION, AND TOXICITY OF SEWAGE CONSTITUENTS TO ZOOPLANKTON. Mercury is concentrated to less than 0.2 to 0.4 ppm in zooplankton collected in unpolluted areas in the North Atlantic while those taken in polluted near-shore areas accumulate up to 5.3 ppm mercury (Windom et al., 1973). Zooplankton can also take up pollutants directly from the surrounding water. For instance, the planktonic larvae of the crab, *Leptodius floridanus,* accumulated 8,000 times as much dieldrin from seawater as from their food (Epifanio, 1973). Nonfeeding adult marine copepods, *Calanus* spp., accumulated internal concentrations of 50 to 1,000 ppm (dry wt.) carbon-14 p,p'-DDT after 3 to 4 weeks of living in seawater containing $\leq$0.45 ppb (Darrow and Harding, 1975).

Toxicity of various substances to zooplankton is shown in Table III-C-2. Although no data on the toxicity of PCB's to zooplankton has been reported, SCCWRP (1973) concluded that PCB's may interact synergistically with DDT to increase DDT toxicity. The opposite situation of an antagonism between the two chlorinated hydrocarbons which effectively decreased their individual toxicities, was reported for phytoplankton in the previous section. The concentrations of toxic constituents in the effluent and sludge and their potential effects are also presented in Table III-C-2.

d. Benthic Invertebrates and Plants.

(1) DISTRIBUTION, ABUNDANCE, AND PRODUCTIVITY OF BENTHIC INVERTEBRATES AND PLANTS. Benthic organisms (benthos) are those which live in close contact with a substrate, temporarily or permanently attached to it, or buried within it. The benthic invertebrates living in or on the deep bottom sediments and attached to the HTP outfall structures in Santa Monica Bay are likely to be the organisms most strongly and detectably affected by discharges from Hyperion Treatment Plant. Because the outfalls are far off-shore, and because there is little evidence that

wastewater constituents move in-shore from the outfalls, there is little likelihood that HTP effluent will directly affect near-shore or beach organisms during normal operation. During proposed construction at HTP, however, effluent will be released through the 1-mile outfall and probably will reach the beaches and subtidal near-shore habitats of Santa Monica Bay. Also, proposed releases of treated wastewater to Ballona Creek and overflows of the existing sewage system that occasionally reach Ballona Creek affect the Ballona Creek mixing zone and the shore and near-shore habitats of Santa Monica Bay. Similarly, existing and proposed discharges from Terminal Island Treatment Plant and proposed discharges from LAGWRP to the Los Angeles River influence the benthic communities of San Pedro Bay. Therefore, for completeness, baseline information is included on all existing benthic habitats in the Southern California Bight that may be influenced by existing, planned, or unexpected sewage discharges.

(a) Intertidal Benthic Habitats.

- Benthos of Sandy Beaches. The majority (80 percent) of the mainland shores of the southern California coast consist of sandy beaches. The shoreline of Santa Monica Bay consists almost exclusively of sandy beaches with some piers and jetties. These sandy beaches do not support luxuriant growth of vegetation because of the unstable nature of the substrate and pounding action of the surf. The only plants capable of sustaining themselves there are the microscopic diatoms and other algae that inhabit the spaces between the sand grains. Seasonal changes in sand deposits (called "littoral drift" (Hedgpeth, 1957)) can open up a rocky shoreline to colonization and subsequently bury it within a few months. Thus, in certain locations a sandy shoreline may become a rocky intertidal habitat and vice-versa depending on seasonal and annual variations in wave action. Most coastal shoreline vegetation is associated with rocky areas discussed later. Where the lower intertidal zone of a sandy coastal shoreline consists of rocky outcroppings, it will support a flora different from that on an adjacent sandy bottom.

Relatively few animals are capable of withstanding the waveshock of the surf-swept sandy beaches. Those that can, do so chiefly by burrowing into the sand for protection. The density of individuals inhabiting a beach is variable due to the constant restructuring of the habitat by wind and waves. However, three basic zones can be delineated:

- Just below the low-tide line
- Between tide lines
- Above the high-tide line

Most animals living above the high-tide line depend on the moisture of ocean spray and organic debris in order to survive, and most reproduce in the ocean. Many beach invertebrates are secretive or elusive, remaining in their burrows most of the time and appearing only at night or on cloudy days.

The size of invertebrates occurring on the beach determines their classification as either macrofauna (greater than 1 mm in diameter), meiofauna (1 mm to 0.1 mm), or microfauna (less than 0.1 mm). The more common invertebrates inhabiting the sandy shores are listed in Appendix III.B.

Two sandy beaches within the Los Angeles-Long Beach Harbor have been surveyed, Inner Cabrillo Beach and Long Beach (1971-1972 and 1973-1974)(Straughan, 1975). These beaches had different biological communities, and both showed a lack of organisms in the upper intertidal levels which is probably related to the beach cleaning activities (removal of food source). A total of 29 species were found on Inner Cabrillo Beach while only 9 were found on Long Beach.

- Benthos of the Rocky Intertidal. Occurrence of attached plants on rocky intertidal shorelines depends on both the strength of the individual holdfast mechanisms and on the seasonal and annual intrusion of shifting sand. Those plants capable of withstanding the wave action may be eliminated from a particular segment of coastline because of the smothering effect of periodically encroaching and receding sand dunes, and as a result, there can be marked seasonal and annual changes in the composition and appearance of rocky shoreline flora. Colonies of plants such as *Enteromorpha, Ulva, Porphyra,* and *Chaetomorpha* (see Appendix III.B. for a list of common intertidal plants) change in appearance as they grow, mature, and decline. In the lower intertidal and just below the low-tide line, attached algae are often more luxuriant than in the true intertidal zone with the large kelp, *Laminaria,* and the flowering plant, *Phyllospadix* (surf grass), dominating (BLM, 1975). In addition to these species, subdominant annual flora occur seasonally.

Rocky intertidal animals situate themselves in vertical zones depending upon the relative duration and periods of tidal exposure and degree of wave shock. Tolerance to desiccation, temperature extremes, salinity variations, and physical assault by wave action determines whether or not individuals will survive or thrive at various levels along the rocky intertidal shoreline. Four basic zones are often described:

- Splash zone - 2.4 to 1.5 meters (5 to 8 feet) above mean lower low water
- High Tide zone - 1.5 to 0.75 meters (5 to 2.5 feet) above mean lower low water
- Mid-tide zone - 0.75 to 0 meters (2.5 to 0 feet) above mean lower low water
- Low Tide zone - uncovered only at minus tide

Heavier wave action can increase the height of these zones. Typical of these zones are the following types of invertebrate fauna:

- Splash zone: hardy, semiterrestrial animals
- High Tide zone: hermit and other crabs, snails in and out of tide pools, barnacles, and other seaside animals attached to the rocks and lush plant growth
- Mid-tide zone:
  - animals living on tops and sides of exposed rocks and ledges
  - animals living on or attached to protected rocks and plants
  - animals living under and between rocks where there is no accumulation of base substratum
- Low Tide zone: tremendously crowded environment containing greater density and diversity of organisms than other levels

Appendix III.B. lists invertebrate fauna common to southern California rocky shores, including those at two specific sites: Abalone Cove on the Palos Verdes Peninsula and Ballona Creek near Venice. Abalone Cove is a typical coastal indentation characterized by a sandy beach partly covered with large boulders. The intertidal community is dominated by *Mytilus californianus* (mussel) and *Phragmatopoma californica* (tube worm), and colonies of the polychaete, *Chaetopterus,* live at the lower level. The entrance of Ballona Creek is marked by two rock jetties extending seaward and directing creek water outward and tidewater into a lagoon. All but the lowest rocks are exposed at low tide. The invertebrate community is dominated by *Mytilus edulis* (bay mussel) and the stalked barnacle, *Pollicipes polymerus* (formerly *Mitrella polymerus).*

At other rocky shore locations north of Los Angeles, both the mussel, *M. californianus,* and the stalked barnacle, *P. polymerus,* are present, but the ocher seastar, *Pisaster ochraceous,* characteristic along with the mussels and barnacles of the most severely wave-struck rocky shores (Ricketts et al., 1968), is generally absent, reflecting the protection from severe wave action afforded by the Channel Islands.

(b) Benthos of Bays, Estuaries and Lagoons. True estuaries are characterized by a continuous influx of fresh water mingling with sea water in an embayment vegetated with a salt marsh plant community. Because of the sparse and highly seasonal runoff from southern California river basins there are no true estuaries adjacent to the Southern California Bight, but there are estuarine zones that have some of the biotic communities of estuaries in lagoons that undergo periodic tidal flushing (such as the Ballona Creek Lagoon) (Figure III-C-6) and in the mouths of rivers that enter into enclosed harbors or artificial embayments (such as in the mouth of the Los Angeles River where it enters Long Beach Harbor).

The salt marsh vegetation of bays is primarily halophytic (salt tolerant) and is subject to periodic flooding by the tide. In addition to halophytes, some forms of marine plants, such as eel grass (*Zostera*) and attached algae, are common. Strong currents and erosive waves

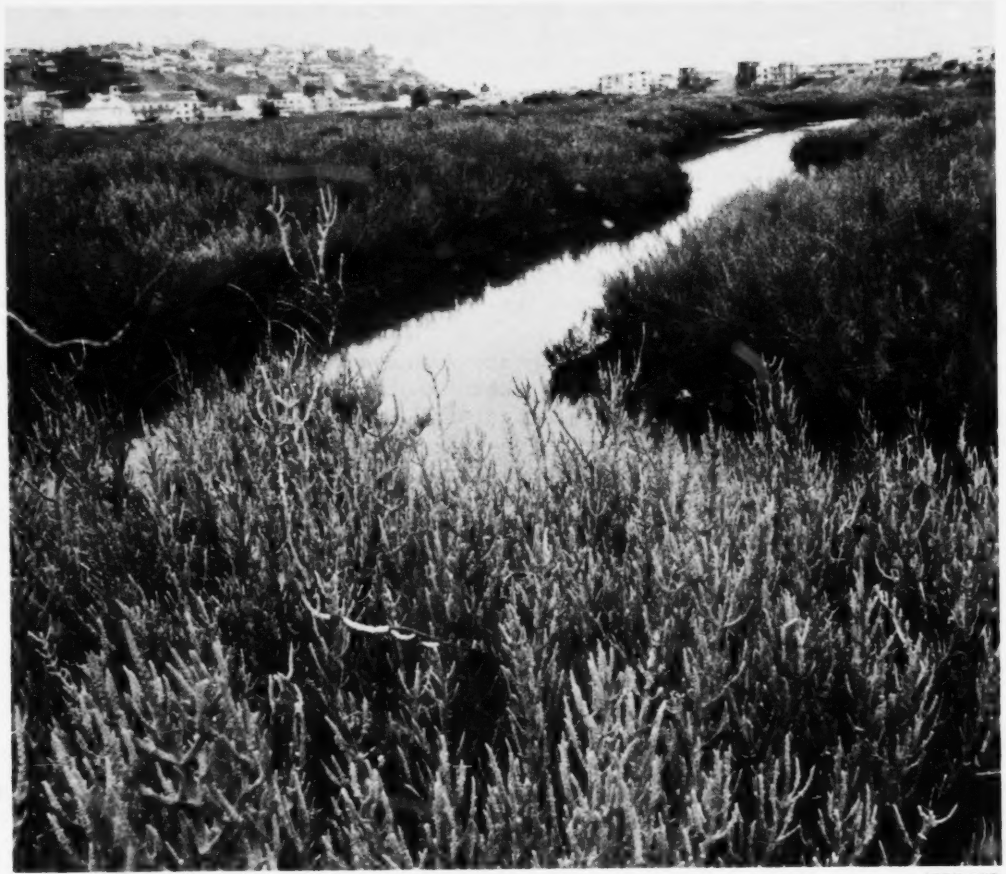

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Figure III-C-6. Ballona Creek Lagoon is an estuary that undergoes periodic tidal flushing.

generally do not occur in salt marshes. The primary plant colonists of salt marshes south of Point Conception are *Spartina foliosa* and *Salicornia bigelovii*. Associated with these dominants are several other species listed in Appendix III.B.

Of the attached algae, *Enteromorpha crinata* is the most abundant and common along the southern California coast in quiet-water areas. This alga can withstand large fluctuations of temperature, salinity, and water availability. Other green algae, *Ulva* spp., have survived and prospered even in the most altered habitats such as harbors and marinas, growing freely on rocks, boats, and floats, especially in spring and fall months.

The only species of brown algae found in bays are *Colpomenia sinuousa*, *Ectocarpus confervoides*, and *Hydroclathurus clathratus*, and these constitute only a small portion of the attached algal population.

Two major intertidal zones occur in most salt marshes. The low marsh zone extends from the lower limit of salt marsh vegetation to the level of mean higher high water (MHHW) where more than six hours of tidal submergence at each tide and less than 15 days of continuous tidal emergence occur. The high marsh zone includes areas between extreme high water and MHHW where there is less than six hours of tidal submergence and where exposure to air can occur for several weeks or months at a time. The area below both these zones is called the tidal flat, where the land is submerged most of the time.

The eel grass, *Zostera marina*, occupies the lowest vegetative zone in unaltered bays. However, in substantially altered bays, such as Mission and San Diego Bays, its presence is reduced to small clumps, while in San Pedro and Alamitos Bays, dredging and other activities of man have eliminated it altogether. Above *Zostera*, *Spartina foliosa* (cordgrass) usually occurs, then *Salicornia bigelovii* (pickleweed) and *Distichlis spicata* (saltgrass), respectively, with occasionally some intermediary zones containing other salt marsh species. Generally, *Spartina* dominates the marsh area.

The subtidal algal flora from the inside and outside of the three breakwaters that protect the Los Angeles-Long Beach Harbor were sampled at a depth of 3 meters in 1973 (Setzer, 1974). Sixty-five species, excluding blue-green algae and diatoms, were recorded with most of the species being small to microscopic algae. Many were epiphytes on other algae. The inner side of the breakwater had fewer species (42) than the outer side (50 species) as well as fewer species (average) per station, 12.8 inside versus 18.9 outside.

The smallest organisms inhabiting the benthic sediments are the microbenthos (those organisms less than 0.1 mm in diameter) which include protozoans, bacteria, and blue-green algae. A variety of ciliate protozoans (including tintinnids) occur in most bays (43 species in San Diego Bay and 23 species in Mission Bay (Lackey, 1967)). These protozoans eat bacteria and algae, while they themselves provide food for larger animals such as copepods. Twenty-five species of benthic Foraminifera were found in Mission Bay (Appendix III.B). The abundance of these organisms varies greatly, with the largest concentrations generally found in the high marsh and the lowest on the tidal flats.

The meiofauna (those organisms ranging in size from 0.1 to 1.0 mm in diameter) consists primarily of nematodes and copepods which usually feed on epigrowth on sand grains or on fine detrital organic deposits. Although nematodes may be the most abundant fauna in southern California marine sediments, their difficult taxonomy has precluded extensive compilation of species lists. Ostracods, similarly, are difficult to identify and may be abundant, providing a relatively important food source for at least one bait-fish, the top smelt (*Atherinops affinis*). The ostracod, *Xestoleberis aurantia*, is found commonly in all marsh habitats, except possibly large sandy channels. Other ostracods that have been collected in bays in southern California are *Cyprideis*, *Loxocomcha*, *Bradleya*, and *Cythereis*. In addition to ostracods, a rare primitive crustacean of the subclass Cephalocarida has been collected from the benthic sediments in Anaheim Bay (BLM, 1975). This crustacean, as yet unidentified to genus, may be one of the most primitive living crustaceans in the world and probably will be placed in a group of which only 3 genera and 8 species are extant.

One hundred and twenty-seven taxa of polychaetes (Appendix III.B) have been collected in the Los Angeles-Long Beach Harbor with the most common being *Capitella capitata*, *Cossura candida*, and *Tharyx* sp. Other benthic invertebrates reported for the harbor are listed in Appendix III.B. The macroinvertebrates found to be most tolerant (and therefore biological indicators) of nutrient enrichment and pollution were the polychaete, *Capitella capitata*, and the amphipods, *Corophium acherusicum*, *C. insideiosum*, and *Podocerus brasiliensis*, all of which were found to the exclusion of most other macroinvertebrates in the Los Angeles-Long Beach Harbor. In contrast, the most common amphipods in Newport Bay were *Amphidentopus oculatus*, *Acuminodentopus heterurupus*, *Rudilemboides stanpropodus*, and *Paraphoxus* sp. These taxa were not found in adjacent intertidal coastal waters and are thought to originate from slightly deeper, calmer waters that compare to conditions in the bays (Barnard, 1961).

Gastropod fauna in southern California bays is usually dominated by the marsh snails, *Assiminea translucens* and *Cerithidea californica*, the latter prospering in Anaheim and Newport Bays. The bay mussel, *Mytilus edulis*, thrives in calm bay water where a hard substrate is available. Associated with this mussel community are 5 species of algae, 22 species of polychaetes, 9 species of amphipods, 11 species of other molluscs, 6 species of ectoprocts, and 6 species of tunicates (Reish, 1964). More species occur during periods of warmer water, while some associated epifauna occur throughout the year without much seasonal fluctuation. Larger individuals of the sand dollar (*Dendraster excentricus*) reached high densities in sandy flat bays such as the Mission Bay Channel, and in off-shore habitats (La Jolla Shores)(Neilson, 1969).

The standing crop of the marsh mollusc fauna in Mission Bay as indicated by biomass (dry weight) remained nearly constant seasonally, while that of the influent creek varied markedly by season, being highest in summer. This change appeared to result from seasonal migrations of the California horn snail, *Cerithidea californica*, to lower elevations for breeding purposes (BLM, 1975).

(c) Benthos of Off-Shore Islands and the Effects of Sewage on These Organisms. The species composition of the southern California island biota is related to the water temperature. Intertidal floral communities have been studied at San Nicolas Island, which is strongly influenced by the cold California Current; Santa Cruz Island, which receives both cold water from the California Current and warmer water from the south; and San Clemente Island, which is bathed exclusively by warmer southern water. Caplan and Boolootian (1967) studied the lower and middle rocky intertidal of San Nicolas Island, finding only 19 species of macrophytes. Both southern and northern California affinities were discovered in the flora which greatly resembled mainland associations. Hewatt (1946) briefly mentioned the presence of macrophytes in the Santa Cruz Island intertidal regions in a study that concentrated mostly upon faunistic assemblages.

On San Clemente Island, Murray and Littler (in BLM, 1975) compared the biota of a sewage-affected cove to control stations. The low volume (20 to 25,000 gallons per day) of raw sewage discharged by a U.S. Navy base was found to reduce species composition and organism distribution of the macrophyte-dominated intertidal community on the leeward side of the island. Thirteen species occurred in the sewage-affected cove and 30 species occurred in adjacent control areas. The species lacking in the sewage-affected cove (which constituted about one-third of the coverage in the unaffected cove) were the brown algae, *Egregia laevigata, Helidrys dioica,* and *Sargassum agardhianum,* the angiosperm, *Phyllospadix torreyi,* and the crustose coralline, *Lithophyllum decipiens.* The species existing in greater abundance in the outfall area were *Ulva californica, Gelidium pusillum,* and *Pterocladia capillacea.*

The subtidal plant community of Anacapa Island which is located in relatively warmer water, is similar, except where strong currents occur, to that in adjacent mainland coastal subtidal settings (Neushul et al., 1967).

Hewatt (1946) collected 488 marine invertebrate species from six areas at Santa Cruz Island: Scorpion Harbor, Smuggler's Cover, Pelican Bay, Prisoner's Harbor, Christy Harbor, and Wellis Harbor. Other than this, few studies exist on island benthic fauna.

Total primary productivity of the intertidal macrophytes exposed to the sewage effluent described above showed no significant difference in productivity from a control cove (127.1 versus 125.4 mg C/m^2 per hour), even though there was 8 percent less cover and about half as many species near the outfall plume. General productivity of macrophytes on the leeward side of San Clemente Island compared favorably with most marine communities in the Southern California Bight (485 net g C/m^2 per year). Macrophytes of the prostrate encrusting forms were the lowest producers, whereas sheet-like and finely-branched forms showed a greater primary productivity than closely-branched forms. Two species located near the outfall, *Gelidium pusillum* and *Ulva californica,* showed the greatest productivity per unit of thallus area of any algae measured.

(d) Mainland Shelf Benthic Habitats: The Most Probable Area of HTP Biological Impact. The mainland shelf is the region into which effluent from Hyperion Treatment Plant is released, and along with submarine canyons and ocean basins, the region in which biological effects of the effluent could be expected to be most pronounced. In this section benthic invertebrate and plant communities inhabiting the mainland shelf along the southern California coast are described first, followed by a description of those known to exist in the vicinity of the Hyperion Treatment Plant outfalls.

Invertebrates inhabiting the mainland shelf (which extends to a depth of about 91 meters) reside mostly in sand, sandy-silt, or silty-sand substrate. In coarse sand, organism density averages 2,500/m^2 and in fine silts, 5,000/m^2 for those individuals greater than 0.7 mm in diameter, or about 60 percent of the total number of macro- and meiofaunal specimens (Jones, 1969). Polychaetes are the most widely distributed taxonomic group, representing 35 percent of all benthic invertebrates collected by the Allan Hancock Foundation survey from 1956 to 1960 in the Southern California Bight (Jones, 1969). About 532 species were identified, with densities averaging 1,400 organisms/m^2. Crustaceans, primarily phoxocephalid amphipods, accounted for 25 percent of the total number of specimens (419 species were identified and had a mean density of 1,500 organisms/m^2). Echinoderms, such as brittle stars, were usually found at depths greater than 10 meters, and the ground assemblage consisted of at least 64 species with an average density of 523 organisms/m^2. Of these, the red brittle star (*Amphioda urtica*) was found in 85 percent of all samples collected below 10 meters and averaged 400 organisms/m^2. Molluscs were also an important group, comprising 408 species with an average density of 368 organisms/m^2. Appendix III.B lists some of the common macro-benthos of the mainland shelf.

Major groupings of benthic invertebrates are classified by their dominant organism(s). The largest of these communities are mapped in Figure III-C-7 and include:

- *Listriolobus* community - dominated by the tongue worm, *L. pelodes*, and limited primarily to sediments near Santa Barbara.
- *Amphiodia* community - dominated by the brittle star, *A. urtica*, which was found in 85 percent of all samples. This species dominates soft bottoms at depths between 40 and 100 meters, especially south of Ventura.
- *Amphiodia/Cardita* community - the brittle star, *A. urtica*, and the clam, *C. vertricosa*, form a community that adjoins the south of the Santa Barbara *Listriolobus* community at depths from about 60 to 100 meters, but ends south of Ventura due to the scarcity of *Cardita*.
- *Chaetopterus* community - the polychaete parchment worm, *C. variopedatus*, forms small isolated concentrations of individuals in tubes overlying black mixed muddy bottoms near San Pedro Hills at a 12 to 40 meter depth. Here, organic content of the sediments is high, and relatively strong currents prevail. Other areas supporting this community are Beckers Cove and Howlands Landing

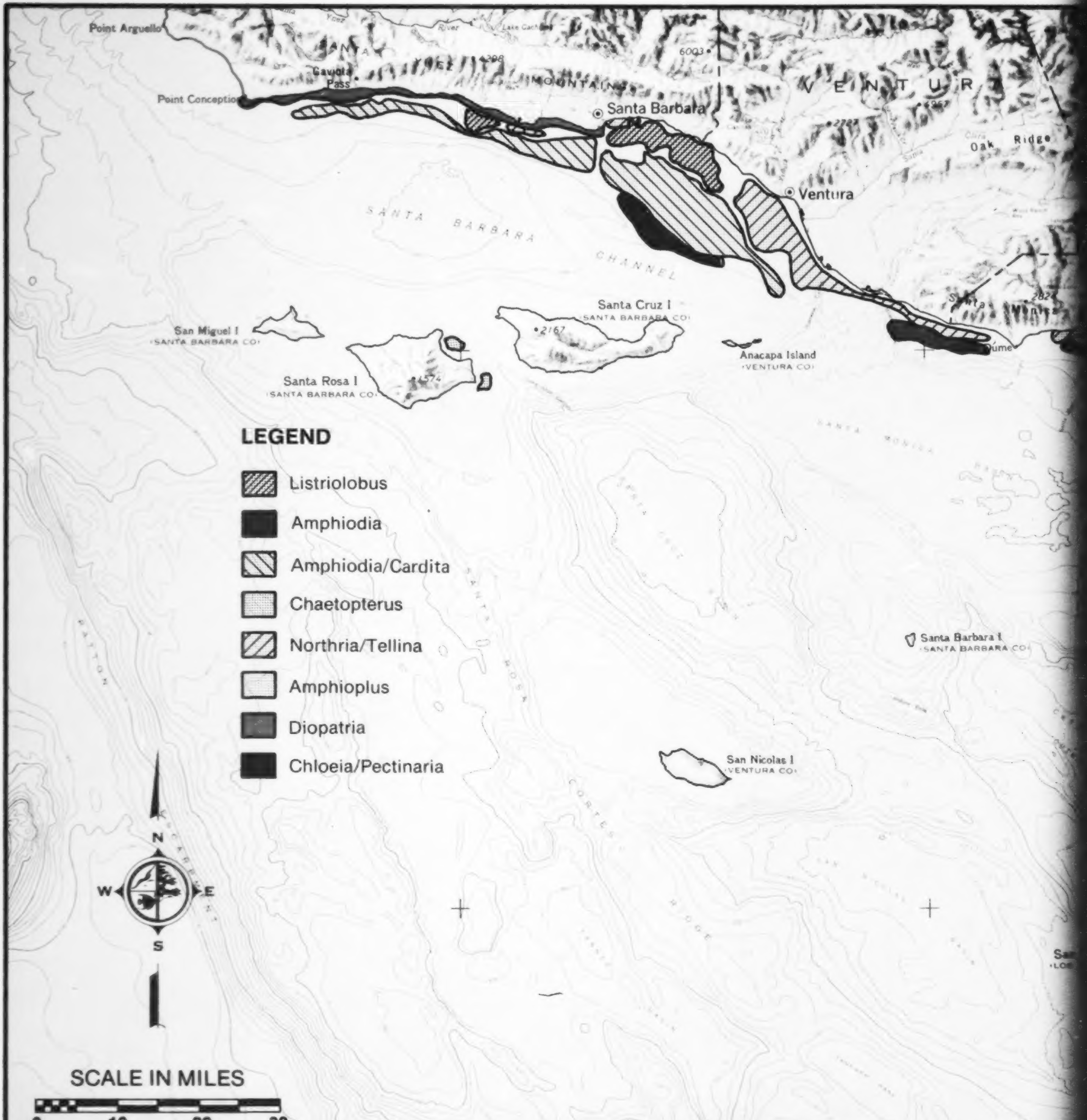
Point Arguello
Point Conception
Gaviota Pass
Santa Ynez Mountains
River
Lake Cachuma
6003
Santa Barbara
V E N T U R
Oak Ridge
Ventura
SANTA BARBARA CHANNEL
Santa Cruz I
SANTA BARBARA CO
•2167
San Miguel I
SANTA BARBARA CO
Santa Rosa I
SANTA BARBARA CO
•1574
Anacapa Island
VENTURA CO
Dume
SANTA MONICA BASIN
Santa Barbara I
SANTA BARBARA CO
San Nicolas I
VENTURA CO
SANTA ROSA CORTES RIDGE
PATTON ESCARPMENT
LEGEND
Listriolobus
Amphiodia
Amphiodia/Cardita
Chaetopterus
Northria/Tellina
Amphioplus
Diopatria
Chloeia/Pectinaria
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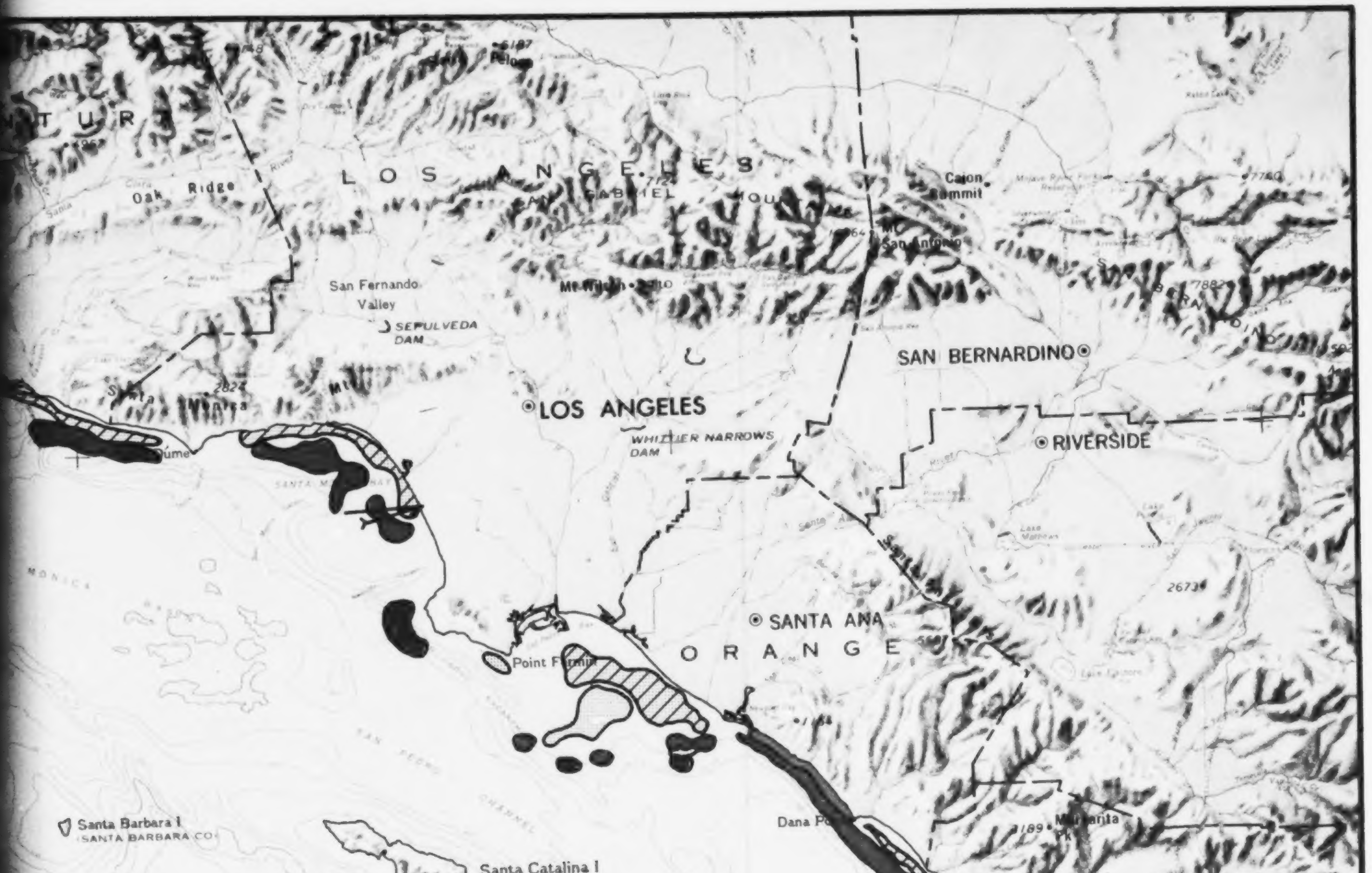
Figure III-C-7. The distribution of benthic macrofaunal associations on the mainland shelf of the Southern California Bight, 1968. Depths are in fathoms (Jones, 1969).

A


LOS ANGELES
Oak Ridge
San Fernando Valley
SEPULVEDA DAM
LOS ANGELES
WHITTIER NARROWS DAM
Cajon Summit
Mt San Antonio
SAN BERNARDINO
RIVERSIDE
SANTA ANA
ORANGE
Point Fermin
SAN PEDRO CHANNEL
Santa Barbara I
(SANTA BARBARA CO)
Santa Catalina I
(LOS ANGELES CO)
Dana Point
GULF OF SANTA CATALINA
San Clemente I
(LOS ANGELES CO)
Point La Jolla
SAN DIEGO
Point Loma

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B

at Santa Rosa Island. Organisms associated with *C. variopedatus* differ at each community location. For instance, at Whites Point, the organism of secondary importance is a clam, *Lima dehiscens;* at Beckers Cove, the polychaete, *Myxicola infundibulim;* and at Howlands Landing, the chaetopterid polychaete, *Owenia* spp. *Chaetopterus* tends to foul boat bottoms and floats in Newport Bay.

- *Nothria/Tellina* community - the polychaete, *N. elegans,* and the button clam, *T. buttoni,* are restricted to bottoms near shore, except off-shore from Ventura where extensive sand sediments allow this community to extend far from shore.
- *Amphioplus* community - the polychaete, *A. hexacanthus,* occurs as a dominant in benthic associations located on the outer continental shelf adjacent to San Pedro Bay and is considered a modification of the *Amphiodia* community.
- *Diopatria* community - the polychaete, *D. ornata,* is located in shallower areas all along the coast, especially where kelp and rocky bottoms occur. Associated with this worm in kelp beds is the nereid worm, *Platynereis bicanaliculata.*
- Slope communities (67 to 200 meter depth) - at least three different slope communities occur, the most important being the *Chloeia/Pectenaria* community - *Chloeia* sp. (stinging worm) and *Pectenaria* (cone worm), both are polychaetes. The large sea urchins, *Briaster* and *Brissopsis,* also occur in this community.
- Smaller communities.
    - *Dendraster* sp. - this sand dollar community often occurs in sand in shallow water.
    - *Ophiura lutkeni* - a brittle star community occurring in deep-water gravel.
    - *Ampelisca* - a tube-building amphipod community occurring in deepwater gravel.
    - *Pherusa/Onuphis* - these polychaetes are abundant in communities at certain points near the Whites Point outfall.
    - *Capitella* - this polychaete community is characteristic of salt-freshwater interfaces and polluted areas such as enclosed bays and harbors. Natural enrichment resulting from excretion of other epifaunal animals, especially in beds of *Diopatria* in kelp and algal fields, provide rich organic mud within which *Capitella* thrives.
    - *Tharyx* - community dominance by the tube-building polychaete, *T. tesselata,* may be considered an indicator of low-level pollution, manmade or natural, such as on the San Pedro Shelf where this community has been observed. *T. parvus* was found to dominate certain bottom areas in Los Angeles Harbor.

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There are many organisms that occur frequently in samples, but rarely in high densities, and never as dominant forms in a community. These are included in the species list in Appendix III.B.

In sandy, shallow portions of the mainland shelf (3 to 9 meters), waves cause the substrate to be unstable, and the environment is harsher for benthic organisms than in slightly deeper water. The types of invertebrates that occur there include those that construct flexible tubes such as the polychaete, *Loimia medusa,* those that occupy deep burrows such as the long neck clams, those that can burrow quickly such as the sand crab, *Blephariopoda,* and those that are spindle shaped such as the lancelot, *Branchiostoma,* the polychaetes, *Prionospio, Ophelia,* and *Nephtys,* and the peanut worm, *Sipunculus.* Marine nematodes were found to be very abundant off-shore near Santa Barbara, Carpinteria, and south of San Diego, although no dominant species were reported. Benthic crustaceans were one-fourth as abundant near-shore as off-shore and were dominated by *Diastylopsis tennius, Paraphoxus epistomus, Mondibalophous uncirostratus,* and *Paraphoxus bicuspidatus.* Molluscs were one-third as abundant near-shore as off-shore, and the most abundant was the small clam, *Tellina buttoni.* Echinoderms were usually lacking in samples collected near-shore although the sand dollar, *Dendraster excentricus,* was taken most often (Allan Hancock Foundation, 1965).

Surveys of benthic animals conducted by the Allan Hancock Foundation between 1956 and 1960 from Point Conception to the Mexican border (Jones, 1969) revealed that polychaetes contributed the greatest biomass to the samples (35 percent), while crustaceans added only 5 percent and bivalve molluscs less, even when weighed with their shells intact. Near Santa Barbara the echuiroid worm, *Listriolobus pelodes,* contributed 80 percent of the benthic faunal biomass. When collected in 1969 (Fauchauld, 1971), this species remained dominant, but with a much reduced biomass as compared to the 1956 to 1960 samples. The maximum total benthic biomass decreased from approximately 2,000 g/m^2 to 850 g/m^2 between the 1956 to 1960 and the 1969 studies, with the drop resulting mainly from a reduction in the biomass of *L. pelodes.* The average biomass of benthic invertebrates was 200 to 300 g/m^2 near Santa Barbara in both studies (Fauchauld, 1971) and 500 to 4,000 g/m^2 for the entire mainland shelf of the Southern California Bight (SCCWRP, 1973).

- Kelp Beds. The dominant plant forming kelp beds along the southern California coast is *Macrocystis pyrifera,* bounded toward the shore by *Egregia* (BLM, 1975). Between the intertidal area and the inner fringes of the kelp occur surf grass (*Phyllospadix*) and several medium-sized brown algae (*Eisenia, Pterygophora, Laminaria,* and *Desmarestia*). Beneath these plants grow numerous smaller green, brown, and red algae (Appendix III.B). The location of most major kelp beds is shown in Figure III-C-8. In the past, kelp has occurred in Santa Monica Bay from Point Dume to past Malibu towards Santa Monica as well as along the Palos Verdes Peninsula.

Many factors control the distribution of kelp including temperature, substrate, waves, light (at bottom), smothering by sediments, grazing,

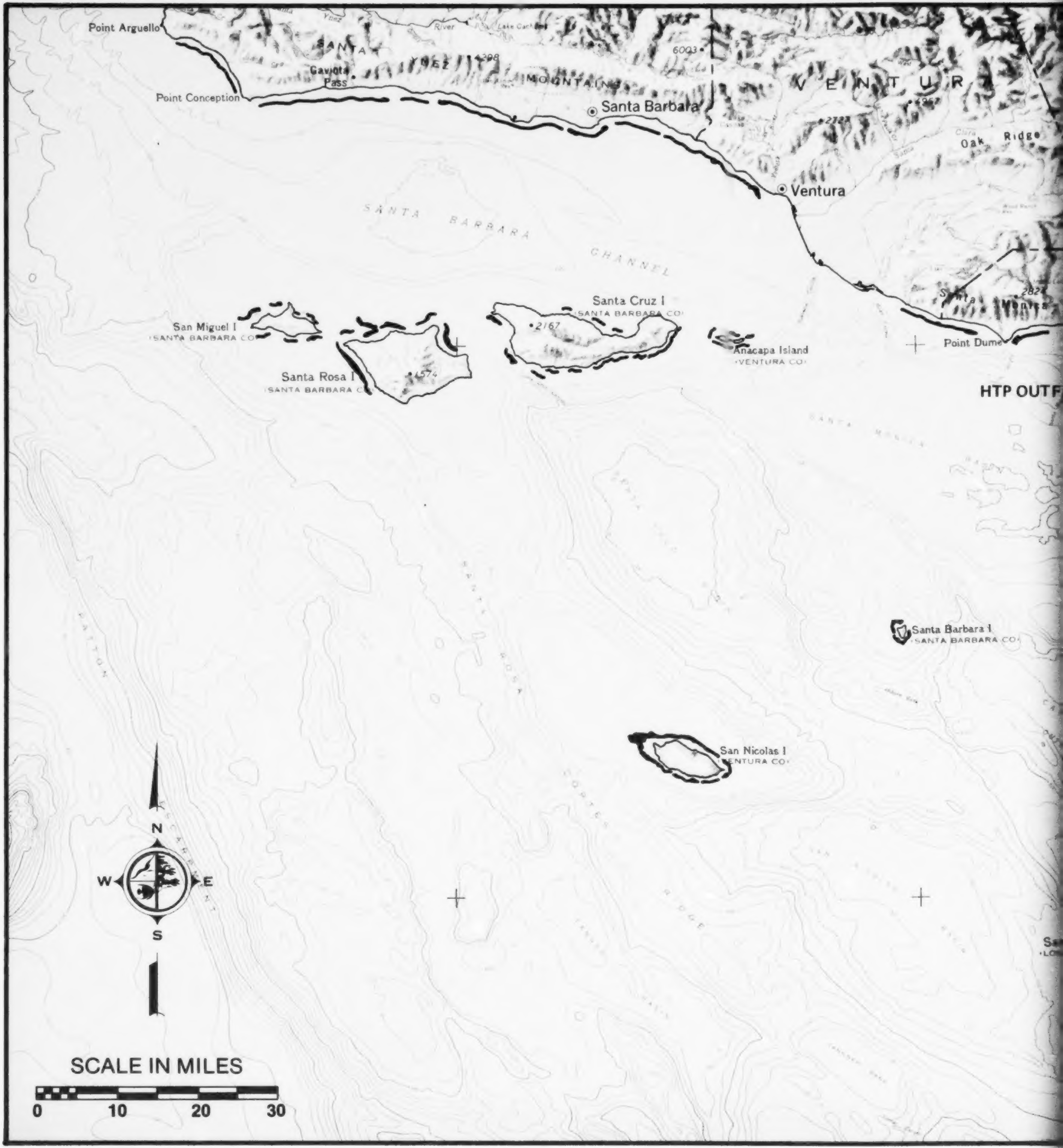
Point Arguello
SANTA YNEZ MOUNTAINS
Gaviota Pass
Point Conception
Santa Barbara
VENTURA
Oak Ridge
Ventura
SANTA BARBARA CHANNEL
San Miguel I
SANTA BARBARA CO
Santa Rosa I
SANTA BARBARA CO
Santa Cruz I
SANTA BARBARA CO
Anacapa Island
VENTURA CO
Point Dume
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Figure III-C-8. Approximate location of kelp beds in the Southern California Bight (from Department of Commerce, 1975a & b). Depths are in fathoms. Data are for 1933-34 surveys.

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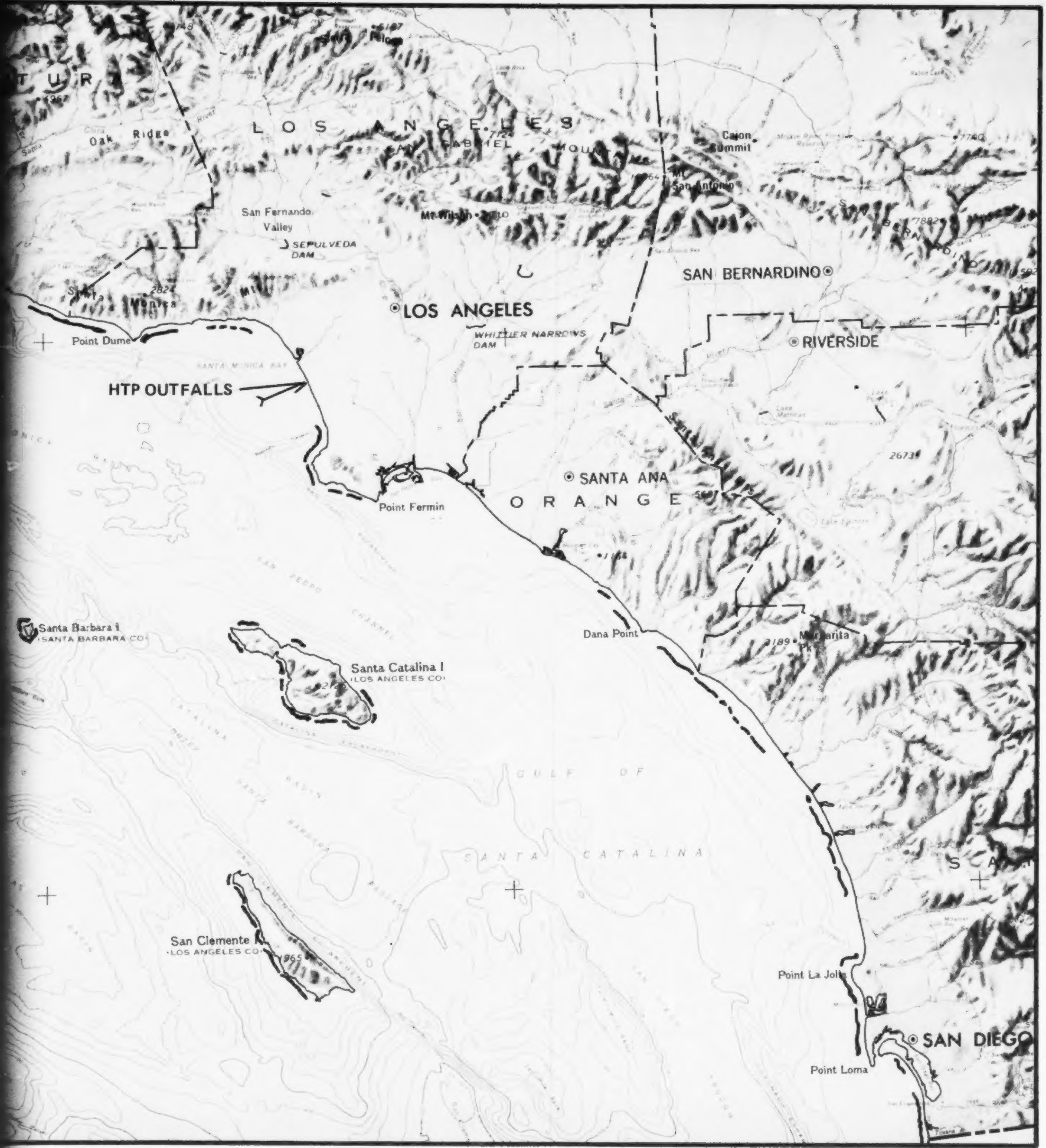LOS ANGELES
SAN GABRIEL MOU
Oak Ridge
Cajon Summit
Mt San Antonio
Mt Wilson
San Fernando Valley
SEPULVEDA DAM
SAN BERNARDINO
LOS ANGELES
WHITTIER NARROWS DAM
RIVERSIDE
Point Dume
SANTA MONICA BAY
HTP OUTFALLS
SANTA ANA
ORANGE
Point Fermin
SAN PEDRO CHANNEL
Santa Barbara I
SANTA BARBARA CO
Santa Catalina I
LOS ANGELES CO
Dana Point
Margarita Pk
GULF OF SANTA CATALINA
San Clemente
LOS ANGELES CO
Point La Jolla
SAN DIEGO
Point Loma

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B

self shading, encrusting growths, pre-emption of bottom by other plants, and black rot (North, 1971). It has been found that different strains of the species of kelp, *Macrocystis pyrifera*, tolerate different maximum temperatures, depending on their natural ranges of temperature. For instance, *M. pyrifera*, indigenous to the Los Angeles area, may thrive only at temperatures less than 20 C, whereas individuals of the same species collected several hundred miles south grow luxuriantly at 26 C (North, 1971). During the period 1957 through 1959, unusually warm water persisted throughout the year causing most kelp of southern California to deteriorate, and some beds even disappeared. Along Palos Verdes, the beds have been showing some regrowth in the past 2 to 3 years (North, 27 July 1977).

Kelp undergoes cyclical natural succession along the coast of southern California (except at Santa Barbara) during which all or part of a kelp bed dies off and new plants grow up (North, 1971). Grazers such as sea urchins, however, can destroy a kelp bed and prevent its return. For instance, the sea urchins, *Strongylocentrotus franciscanus* and *S. purpuratus* were found to have dense populations ($\geq 50/m^2$ at Palos Verdes) where kelp beds formerly occurred, and these high densities prevent kelp re-establishment by cropping young sporophytes (North and Pearse, 1970). Removal of the urchins allowed kelp and other vegetation to grow in this area. The increase in the urchin population is probably caused by removal of otters (urchin predator), depletion of abalone (food and substrate competitor), and sewage (potential food source for urchins)(North and Pearse, 1970).

The various invertebrates of kelp beds are supported in their respective niches by several factors:

- Primary production of the kelp provides food for herbivorous invertebrates.
- The kelp structure provides a substrate for encrusting organisms, primarily filter feeders.
- Shelter is also provided, especially for organisms relying on camouflage for protection and food acquisition.
- Animals avoiding light are drawn to the shade of kelp beds.

Of these invertebrates, 74 common species are listed in Appendix III.B, while more than 625 have been identified (Bright, 1974).

A number of invertebrates depend indirectly on the kelp bed for sustenance. These are sessile filter-feeders, carnivores, and scavengers. The sessile invertebrates may colonize the fronds, stipes, and holdfasts of the kelp or the sea floor below the kelp. The benthic invertebrates found underneath the kelp are usually older than the periphytic invertebrates because of the greater stability of the hard substrate. Common types of kelp bed filter-feeders are ectoprocts, hydroids, crustaceans, and sponges. Less common filter-feeders are pelecypods, gorgonian corals, and polychaete worms. Invertebrate herbivores intermediate in the trophic structure of the food web are sea urchins and gastropod molluscs such as

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abalone and snails, while carnivores include scyphozoans, starfish, cephalopods, crustaceans, and anthozoans. Scavengers include polychaetes, sea urchins, holothruians, anthozoans, crustaceans, gastropods, and starfish.

Giant kelp stipes have been observed to grow from 30 to 61 cm/day (12 to 24 inches/day) during periods of optimum conditions of clear cool water (below 20 C) when nutrients are not limiting. Clendenning (1971) has reported that the annual production of a "good" kelp bed is 14.6 to 15.0 metric tons/hectare•year.

- Reefs (without kelp). There are a number of off-shore reefs (essentially raised areas of hard substrate) that are not inhabited by kelp. These include natural rock reefs, artificial reefs placed intentionally to provide reef habitat, and solid structures such as drilling platforms and sewage outfall pipes that provide reef habitat incidental to their intended function.

In this section the organisms of natural off-shore reefs are discussed first, then those of intentional artificial reefs, followed by a discussion of the benthic fauna inhabiting the Hyperion outfall structures (by far the deepest of the artificial reefs that have been studied in the Southern California Bight). Kelp does not inhabit or utilize the natural off-shore reefs discussed below, although other algal species may occur. The flora of these reefs has not been well characterized. Invertebrates of these reefs have been studied only in a few locations in the Southern California Bight (Pequegnat, 1963, 1964, 1968). The siltstone reefs located about 200 and 500 meters (9.5 to 18 meters deep) off the coast near Corona del Mar appear to support epifauna with as many or more species per unit area than any other location on land or sea. Surface water movement keeps much of the sediment in suspension in upper portions of the reefs, whereas deposition or organic materials is enhanced at greater depth with reduction of general water turbulence. Water temperature varies by as much as 6 C between the top and bottom of the reef located 500 meters from shore. The shallower reef (200 meters from shore) is located above the thermocline. Reef portions above the thermocline show greatest densities of such southern species as the rock oyster, *Chama pellucida,* and levels below the thermocline support greatest concentrations of northern species, such as *Henricia levisucula* (starfish). All in all, between 300 to 400 species of macroscopic invertebrates have been described as living on the reefs, which have an area of only 1,385 m^2. These organisms have been characterized into four groups, depending upon their respective levels of habitation on the reefs. Reef-top (9.5 to 12.5 meters deep) and mid-reef (12.5 to 14.5 meters) levels are dominated by sessile suspension feeders (rock oyster, *Chama pellucida,* and calcareous ectoprocts) which form thick encrustations that support large numbers of small sessile and motile species. The reef-base zone (14.5 to 16.5 meters) is occupied by large sea urchins and deposit-feeding sea cucumbers, while the mixed bottom zone (more than 16.5 meters) is located on the adjacent ocean bottom of rock slabs and sediments and supports a variety of infaunal and epifaunal organisms. There is a general top to bottom decline in number of species and individuals (Table III-C-6). The Tanner and Cortes Banks, located past San Clemente Island, are reported to have hard bottoms and also support enriched fauna and flora.

Table III-C-6. Characteristics of reef biota at a siltstone reef 500 meters offshore from Corona del Mar (data from Pequegnat, 1964).

REEF ZONE	AREA SAMPLED (m^2)	NUMBER OF SPECIES			DRY WEIGHT (g/m^2) (CATEGORIZED BY FEEDING TYPES)				
		IN ZONE	PER 0.1 m^2 (MEAN VALUE)	WITH MAXIMUM POPULATION IN ZONE	SUSPENSION FEEDERS	CARNIVORES	SCAVENGERS	HERBIVORES	DEPOSIT FEEDERS
Reef Top (9.5 to 12.5 m deep)	550	189	89	131	2,238.4	219.8	122.8	37.6	0.1
Mid Reef (12.5 to 14.5 m deep)	400	144	80	87	1,120.4	128.0	117.1	37.6	4.5
Reef Base (14.5 to 16.5 m deep)	250	114	49	51	202.5	53.9	45.1	63.3	10.9
Mixed Bottom (16.5 to 18.5 m deep)	185	47	21	31	55.6	25.0	63.3	6.6	24.0

The enhancement of marine benthic substrates by placing hard, protective substrates in a normally barren, soft-bottomed area has been studied in detail in the Los Angeles and Santa Barbara areas since 1958 (Carlisle et al., 1964; Turner et al., 1969). For many years, divers have observed the faunal and floral growths on submerged pilings supporting coastal piers, which are for the most part limited to shallow water. In 1958 Carlisle et al. (1964) observed an experimental car body reef installed in 15 meters (50 feet) of water in Paradise Cove, Santa Monica Bay, and a streetcar reef off Redondo Beach in 18 meters (60 feet) of water. In 1960, three replication reefs were placed several miles apart in Santa Monica Bay at a depth of 18 to 23 meters (60 to 75 feet). Each was composed of car bodies, a streetcar, quarry rock, and concrete shelters. Finally, four off-shore drilling installations in 15 to 34 meters (50 to 110 feet) of water and one artificial oil island built up in 12 to 18 meters of water were surveyed for evidence of colonization by marine biota.

It was found that approximately five years was required for the new installations to attain a "natural situation." After that time, a very productive habitat supporting a diverse and dense assemblage of benthos and shelter-seeking nektonic invertebrates and fish was established. Car and streetcar bodies were of limited usefulness because they disintegrated or were buried after 3 or 4 years. Oil platforms quickly attracted (within 3 years) a dense and diverse assemblage of biota that showed a distinct zonation of dominant organisms with depth to the bottom of the installation (less than 34 meters). Rincon Oil Island supported organisms typical of the rocky intertidal.

- Hyperion Treatment Plant Outfall Structures as Substrates for Benthic Organisms. No studies of any other artificial substrates in the Southern California Bight at depths greater than the oil platforms have been reported, except for the recent visual investigation of the Hyperion Treatment Plant 5- and 7-mile outfall pipe structures (Allen et al., 1976). In June and July of 1974 seven major regions in three major depth zones along the effluent pipes were photographed to identify the organisms residing on or near the pipes. The shallow zone of 10 to 30 m was photographed by Harry Pecorelli using SCUBA while in the deeper zones, 40 to 50 m and 60 to 100 m, were photographed from a two-man submarine. The regions sampled and the most frequently observed organisms are shown in Figure III- -9. At least 100 species were observed in the photographs of which two-thirds were invertebrates. Only three species of algae were identified, all Rhodophyceae (red alga). The species found and the sampling region in which each occurred is presented in Table III-C-7.

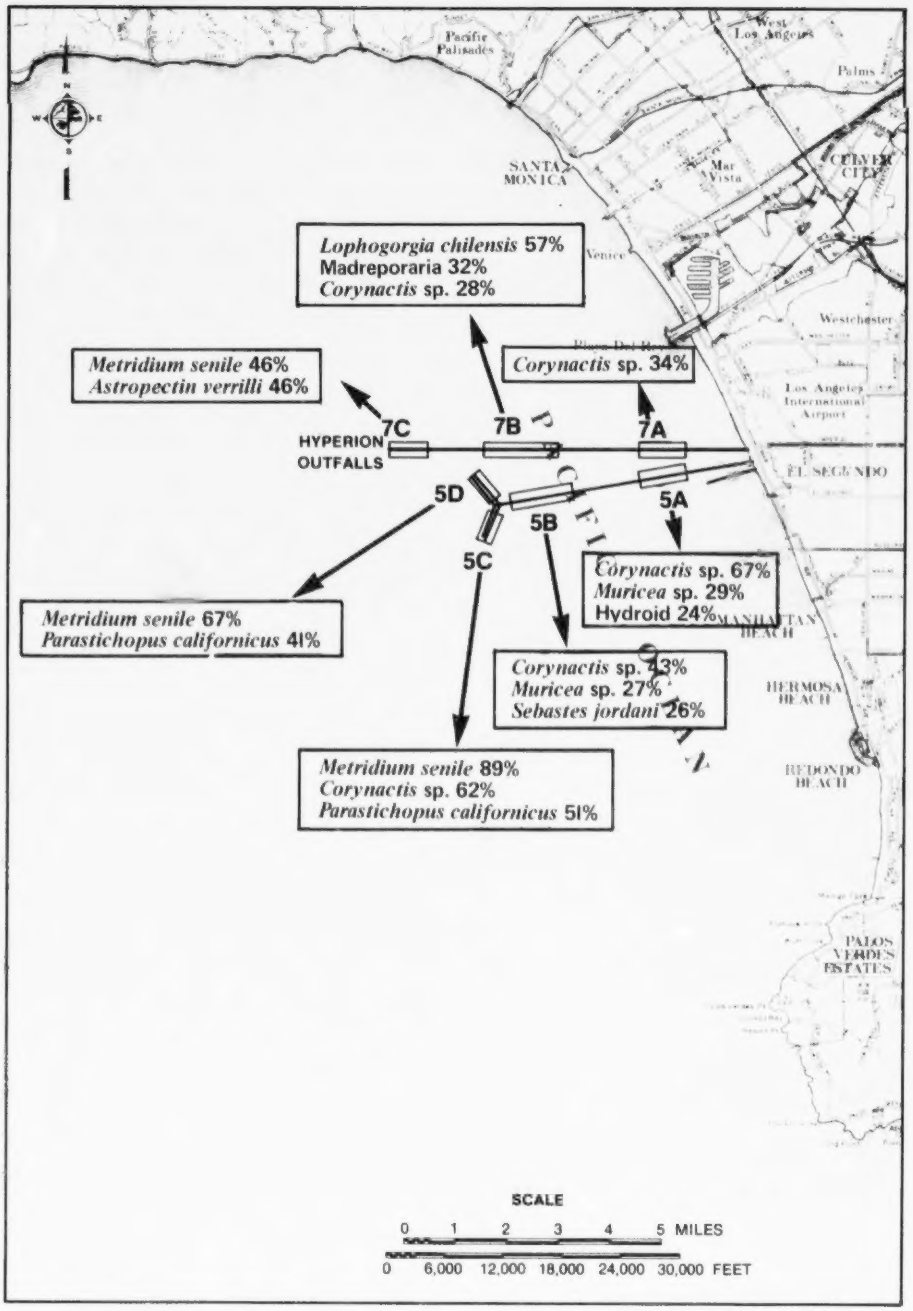
Figures III-C-10 through 14 are line drawings (modified from Allen et al., 1976) showing the outfall pipes and the characteristic distributions of organisms seen in 5 percent or more of the photographs taken along them. The general locations of the portions of the outfall structures depicted are keyed to locations identified in Figure III-C-9.

The outfall pipes provide a hard substrate in an area that generally has a soft bottom. The concrete anchor blocks on the 7-mile pipe and the rock ballast on the 5-mile pipe in shallow water also provide solid substrates as well as crevices. Sessile suspension feeders are commonly found all along both pipes with the aggregate anemone (*Corynactis* sp.), gorgonian corals (*Muricea* sp. and *Lophogorgia chilensis*), and hydroids dominating in shallow water, and the large white sea anemone (*Metridium senile*) dominating in deeper water (Allen et al., 1976). The large white anemone was clustered around the diffuser ports on the 5-mile pipe and at the end of the 7-mile pipe. This distribution pattern around the discharge openings may be in response to a food source (sewage) or to the water currents caused by the discharge. Crabs and lobsters were noted utilizing the crevices in the rock ballast and anchors in shallow water, and red algae were found only at the shallow area on the 5-mile pipe. Differences in the species composition and abundances on the two pipes may be related to the differences in pipe size (3.7 meter diameter for the 5-mile and 0.6 meter diameter for the 7-mile) and construction material.

Because no other studies have been reported for comparable artificial substrates at these depths, the importance of the effluent in maintaining the attached fauna is unknown.

(e) Effects of Sewage Outfalls on the Species Composition and Abundance of Mainland Shelf Benthic Communities.

- Whites Point. Kelp beds began deteriorating along the Palos Verdes penninsula around 1950 with damage beginning closest to the JWPCP (Whites


Pacific Palisades
West Los Angeles
Palms
SANTA MONICA
Mar Vista
CULVER CITY
Venice
Westchester
Playa Del Rey
Los Angeles International Airport
EL SEGUNDO
MANHATTAN BEACH
HERMOSA BEACH
REDONDO BEACH
PALOS VERDES ESTATES
PACIFIC OCEAN
N
S
W
E
Lophogorgia chilensis 57%
Madreporaria 32%
Corynactis sp. 28%
Metridium senile 46%
Astropecten verrilli 46%
Corynactis sp. 34%
7C
7B
7A
HYPERION OUTFALLS
5D
5C
5B
5A
Corynactis sp. 67%
Muricea sp. 29%
Hydroid 24%
Metridium senile 67%
Parastichopus californicus 41%
Corynactis sp. 43%
Muricea sp. 27%
Sebastes jordani 26%
Metridium senile 89%
Corynactis sp. 62%
Parastichopus californicus 51%
SCALE
0 1 2 3 4 5 MILES
0 6,000 12,000 18,000 24,000 30,000 FEET

198P-271

Figure III-C-9. Regions along the Hyperion 5-mile and 7-mile effluent pipes photographed by two-man submarine and SCUBA divers during June and July 1974. The depths are 10 to 30 m at 5A and 7A, 40 to 50 m at 5B and 7B, 60 m at 5C and 5D, and 60 to 100 m at 7C. The most frequently observed organisms are listed for each station with percent occurrence (adapted from Allen et al., 1976).

Table III-C-7. Marine organisms observed near the Hyperion 5- and 7-mile wastewater discharge pipes in a SCUBA and submarine survey in June-July 1974. The occurrence in 5 percent or more of the photographs is given for each region along the pipe. Question marks indicate that the identification is uncertain (Allen et al., 1976) (Page 1 of 2).

SPECIES	COMMON NAME	≥5% OCCURRENCE IN EACH REGION[1]						
		5A	5B	5C	5D	7A	7B	7C
Rhodophyta								
Rhodophyceae								
Gigartina corymbifera	red alga	X						
Iridaea splendens	red alga	X						
Rhodophyceae, unid.[2]	red alga	X						
Rhodymenia pacifica	red alga	X						
Porifera								
Porifera, unid.	sponge					X		
Cnidaria								
Hydrozoa								
Aglaophenia sp.	hydroid	X						
Hydroid, unid.	hydroid	X				X		
Scyphozoa								
Pelagia sp.	jellyfish							
Anthozoa								
?*Acanthoptilum* sp.	sea pen							
Actinaria, unid.	sea anemone							
Ceriantharia, unid.	tube anemone	X					X	
Corynactis sp.	sea anemone	X	X	X	X	X	X	
Eugorgia rubens	gorgonian							
Lophogorgia chilensis	gorgonian	X	X			X	X	
Madreporaria, unid.	hard coral		X				X	
Metridium senile	sea anemone		X	X	X			
Muricea sp.	gorgonian	X	X					
Pennatulacea, unid.[2]	sea pen				X			
Stylatula sp.	sea pen							
Annelida								
Polychaeta								
?*Diopatra* sp.	polychaete							
Phyllochaetopterus sp.	polychaete							
Polychaete tubes, unid.	polychaete							
Serpulidae, unid.	polychaete	X						
Telepsavus costarum	polychaete							
Arthropoda								
Crustacea								
Balanus sp.	barnacle							
Cancer antennarius	rock crab							
Cancer anthonyi	yellow crab	X						
Cancer productus	crab	X						
Cancer sp.[2]	crab							
Cirripedia, unid.[2]	barnacle							
Loxorhynchus grandis	sheep crab	X						
Mursia gaudichaudii	crab							
Paguridae, unid.	hermit crab							
Panulirus interruptus	California spiny lobster					X		
Scalpellum sp.	barnacle							
Mollusca								
Gastropoda								
Aegires albopunctatus	sea slug							
Bursa californica	California frog shell							
Calliostoma gloriosum	snail							
Conus californicus	California cone							
Crassispira semiinflata	snail					X		
Doridoidea	sea slug							
Gastropod, unid.[2]	snail			X				
Gastropod, unid.	*Ocenebra*-like snail							
Gastropod eggs, unid.[2]	gastropod eggs							
Hermissenda crassicornis	sea slug							
Kelletia kelleti	Kellet's whelk		X		X	X	X	X
Kelletia kelleti, eggs	Kellet's whelk, eggs					X		
Megasurcula carpenteriana	snail					X	X	X
Megathura crenulata	giant keyhole limpet	X						
Nassarius sp.	snail							
Naticidae, unid.	moon snail							
Neverita altus	snail							
Nudibranchia?, unid.[2]	sea slug							
Opisthobranchia eggs, unid.[2]	sea slug, eggs							
Terebra sp.	snail					X	X	X
Tritonia diomedea	sea slug							

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Table III-C-7. (Page 2 of 2)

SPECIES	COMMON NAME	≥5% OCCURRENCE IN EACH REGION[1]						
		5A	5B	5C	5D	7A	7B	7C
Mollusca (cont.)								
Pelecypoda								
Anomiidae, unid.	jingle							
Hinnites giganteus	rock scallop					X		
?*Macoma* sp.	clam							
Pelecypoda, unid.	clam							
Solemya sp.	clam							
Zirfaea sp.	clam							
Cepahlopoda								
Octopus sp.	octopus							
Ectoprocta								
Ectoprocta, unid.	moss animal	X						
Echinodermata								
Asteroidea								
Asteriinae, unid.	starfish				X			
Astropectin verrilli	sand star						X	X
?*Henricia* sp.	star							
Mediaster aequalis	star							
Patiria miniata	bat starfish							
Petalaster foliolata	star							X
Pisaster brevispinis	starfish	X						
P. giganteus	giant spined starfish							
P. ochraceus	common starfish							
P. sp.[2]	starfish							
Echinoidea								
Lytechinus ?anamesus	sea urchin							
?*Strongylocentrotus* sp.	sea urchin							
Holothuroidea								
Holothuroidea, unid.	sea cucumber							
Parastichopus californicus	sea cucumber		X	X	X		X	
P. parvimensis	sea cucumber	X						
Chordata								
Aschidiacea								
Styella sp.	sea squirt							
Chondrichthyes								
Hydrolagus colliei	ratfish		X					
Osteichthyes[3]								
Chitonotus pugetensis	roughback sculpin							
Citharichthys stigmaeus	speckled sanddab							
Coryphopterus nicholsi	blackeye goby							
Cymatogaster aggregata	shiner perch							
Embiotocidae, unid.[2]	perch							
Hippoglossina stomata	bigmouth sole							
Icelinus tenuis	spotfin sculpin							
Lepidogobius lepidus	bay goby							
Microstomus pacificus	dover sole							X
Neoclinus uninotatus	onespot fringehead							
Osteichthys, unid.[2]	fish							
Oxylebius pictus	painted greenling						X	
Pleuronectiformes, unid.[2]	flatfish							
Pleuronichthys coenosus	C-O sole							
Pleuronichthys sp.[2]	turbot							
?*Rathbunella* sp.	ronquil							
Scorpaena guttata	California scorpionfish							
Scorpaenichthys marmoratus	cabezon							
Sebastes auriculatus	brown rockfish					X		
S. ?dalli	calico rockfish							
S. ensifer	swordspine rockfish			X				
S. flavidus	yellowtail rockfish							
S. ?goodei	chilipepper							
S. jordani	shortbelly rockfish		X	X	X		X	X
S. levis	cow rockfish			X	X			X
S. miniatus	vermilion rockfish			X	X		X	X
S. mystinus	blue rockfish			X				
S. paucispinis	bocaccio			X	X			X
S. rubrivinctus	flag rockfish			X	X			
S. saxicola	stripetail rockfish							
S. semicinctus	halfbanded rockfish							
S. serranoides	olive rockfish			X			X	
S. sp.[2]	rockfish				X		X	
S. vexillaris	whitebelly rockfish				X			
Zalembius rosaceus	pink seaperch						X	

[1] See Figure III-C-9 for region locations.

[2] Unidentifiable species, although not necessarily different from those identified in the photographs.

[3] Common names of fishes are from Bailey et al., 1970.

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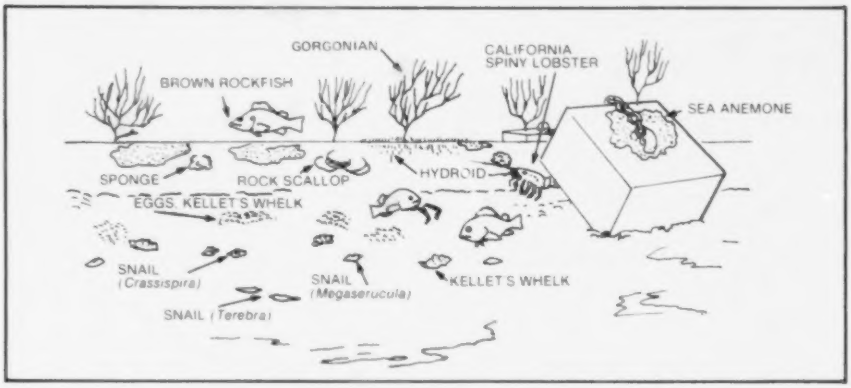
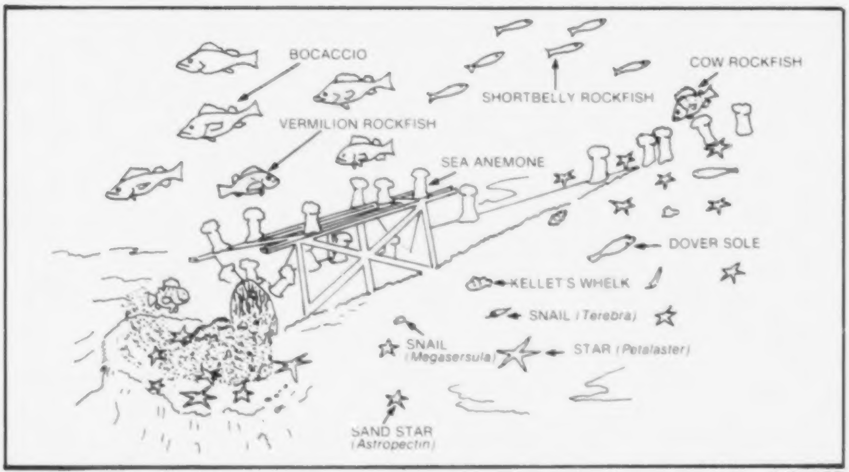
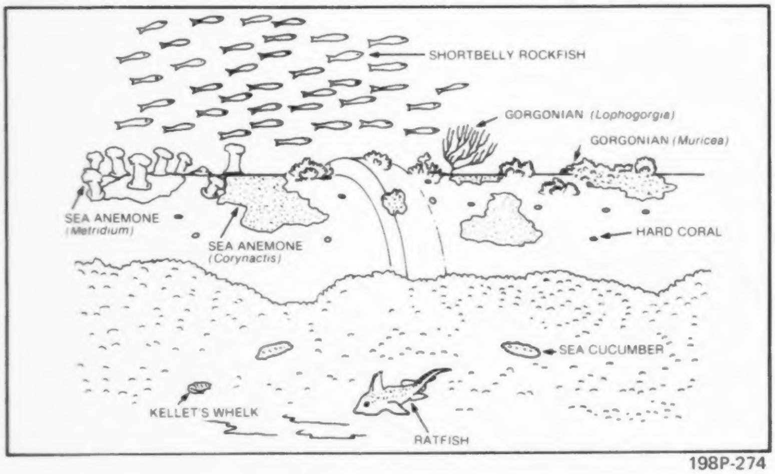

GORGONIAN
CALIFORNIA SPINY LOBSTER
BROWN ROCKFISH
SEA ANEMONE
SPONGE
ROCK SCALLOP
HYDROID
EGGS, KELLET'S WHELK
SNAIL (*Crassispira*)
SNAIL (*Megaserucula*)
KELLET'S WHELK
SNAIL (*Terebra*)

Figure III-C-10. Marine organisms found in 5 percent or more of the photographs taken of the Hyperion Treatment Plant 7-mile outfall (region 7A, Figure III-C-9). The concrete anchor blocks with connecting chain help to hold the pipe down (drawing modified from Allen et al., 1976).


BOCACCIO
COW ROCKFISH
SHORTBELLY ROCKFISH
VERMILION ROCKFISH
SEA ANEMONE
DOVER SOLE
KELLET'S WHELK
SNAIL (*Terebra*)
SNAIL (*Megasersula*)
STAR (*Petalaster*)
SAND STAR (*Astropectin*)

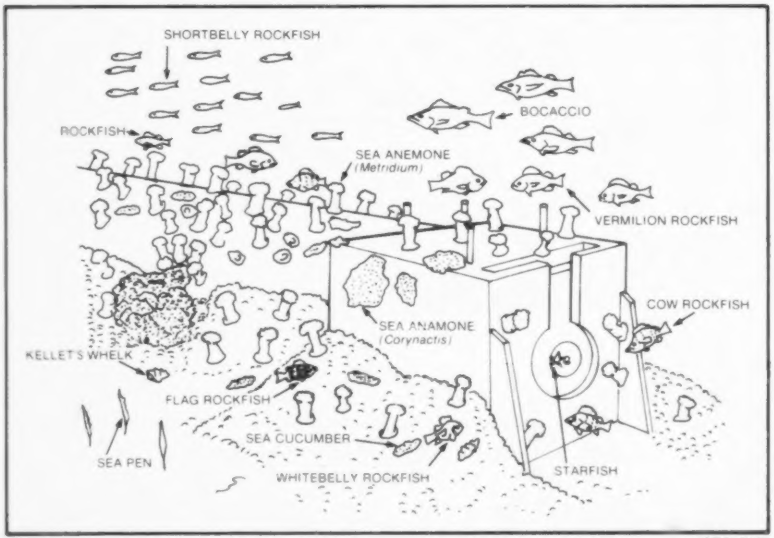
198P-273

Figure III-C-11. Marine organisms found in 5 percent or more of the photographs taken near the end of the Hyperion Treatment Plant 7-mile outfall (region 7C, Figure III-C-9). Mixed sludge and secondary effluent is depicted leaving the end of the pipe. The sled used to drag the pipe to its present position is still attached. During emplacement and positioning the pipe rotated and the runners are now on the upper side of the pipe. The sled superstructure imperils benthic sampling, trawling, and remote photography in its vicinity (drawing modified from Allen et al., 1976).


SHORTBELLY ROCKFISH
GORGONIAN (Lophogorgia)
GORGONIAN (Muricea)
SEA ANEMONE (Metridium)
SEA ANEMONE (Corynactis)
HARD CORAL
SEA CUCUMBER
KELLET'S WHELK
RATFISH

198P-274

Figure III-C-12. Marine organisms present in 5 percent or more of the photographs taken of the Hyperion Treatment Plant 5-mile outfall pipe just inshore from the Y (location 5B, Figure III-C-9) (modified from Allen et al., 1976).


SHORTBELLY ROCKFISH
BOCACCIO
ROCKFISH
SEA ANEMONE (Metridium)
VERMILION ROCKFISH
COW ROCKFISH
SEA ANAMONE (Corynactis)
KELLET'S WHELK
FLAG ROCKFISH
SEA CUCUMBER
SEA PEN
WHITEBELLY ROCKFISH
STARFISH

198P-275

Figure III-C-13. Marine organisms present in 5 percent or more of the photographs taken in the vicinity of the Hyperion Treatment Plant 5-mile outfall north diffuser leg (location 5D, Figure III-C-9). Discharge of effluent (mixed primary and secondary effluent) is shown through one of the ports along the length of the diffuser leg (modified from Allen et al., 1976).

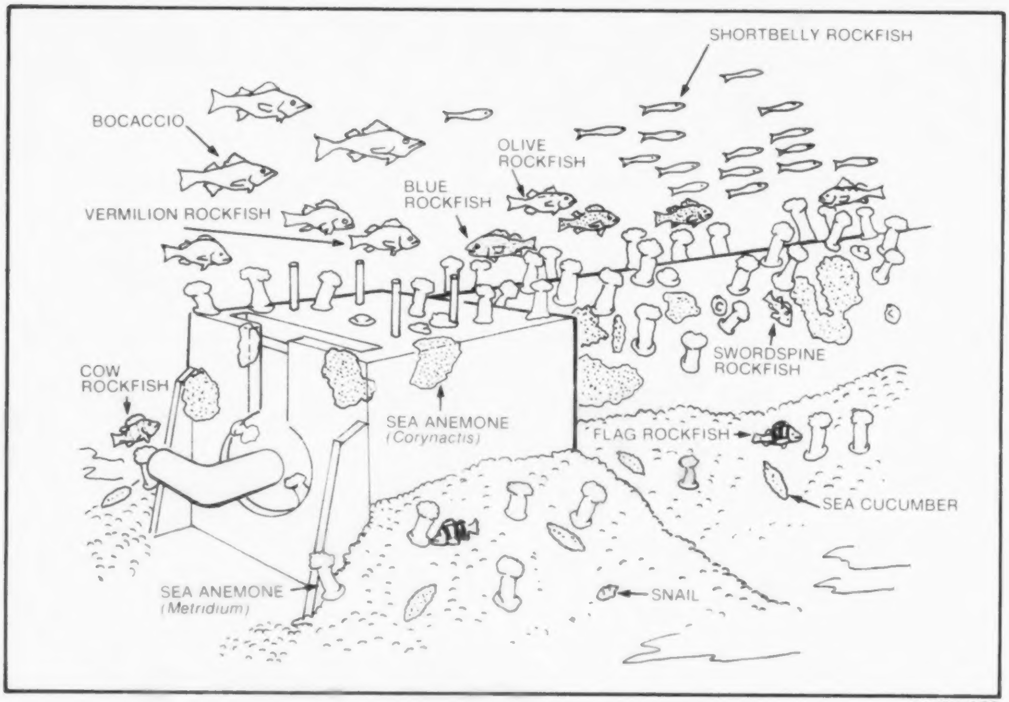

SHORTBELLY ROCKFISH
BOCACCIO
OLIVE ROCKFISH
BLUE ROCKFISH
VERMILION ROCKFISH
SWORDSPINE ROCKFISH
COW ROCKFISH
SEA ANEMONE (Corynactis)
FLAG ROCKFISH
SEA CUCUMBER
SEA ANEMONE (Metridium)
SNAIL
198P-276

Figure III-C-14. Marine organisms present in 5 percent or more of the photographs taken along the south diffuser leg of the Hyperion Treatment Plant 5-mile outfall (location 5C, Figure III-C-9). The elbow pipe extending from the end of the diffuser leg diverted effluent flow to the north before it was plugged (modified from Allen et al., 1976).

Point) outfalls and moving progressively farther away (SWQCB, 1964). The volume of the JWPCP effluent approximately doubled between 1946 and 1949 when the kelp decline began. The causes of the continued decline have not been clearly established; however, grazing (particularly by sea urchins) is the most likely cause with changes in water clarity also having some effect.

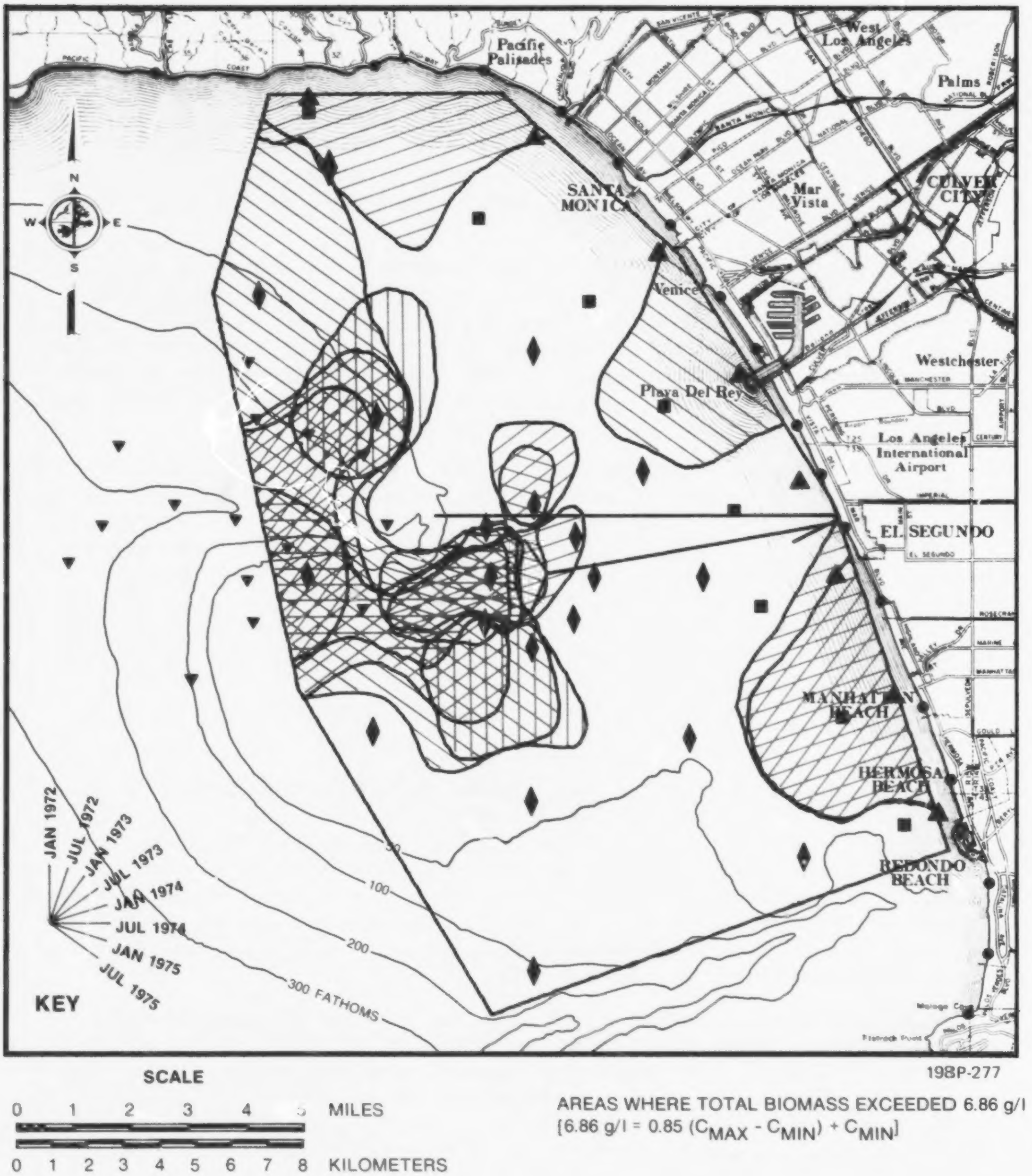
A diving study along the 60-foot depth contour at Whites Point showed that the effects of the outfall increased from 1.2 to 3.2 km (0.75 to 2 miles) in 1954 to 9.7 km (6 miles) in 1969 (Grigg and Kiwala, 1970). No algae were found close to the outfalls apparently as a result of deposits on the bottom modifying the substrate. There was a statistically negative correlation between the number of species and the amount of fine grain, organic-laden sediment present.

Faunal similarities have been compared by ranking groups of species that, although they are not dominant in a community, occur together more than 50 percent of the time when one or the other is found (SCCWRP, 1973). Forty-eight species have been found that were in recurrent groups 65 percent of the time: 23 polychaetes, 18 crustaceans, 2 echinoderms, 2 molluscs, and 3 other taxa. Twenty-eight of these species could be arranged in seven recurrent groups. SCCWRP (1973) reported four recurrent groups of polychaetes found near the Whites Point outfall, and it was found that the *Capitella capitata/Stauronereis rudolphi/Ophiodromus pugettensis* community was most closely associated with the outfalls.

- Hyperion Treatment Plant. Since 1971, Hyperion Treatment Plant has conducted approximately semi-annual benthic sampling at the locations identified in Figure III-B-6. The samples were analyzed for species of organisms present and their abundance, but total biomass (weight of organisms per volume of sediment, g/l) of only a few taxonomic categories (class Polychaeta, phylum Mollusca, class Crustacea, and phylum Echinodermata) and an index of species diversity have been reported regularly in the HTP Annual Reports.

The unprocessed species data from 1973 to present have been made available recently from HTP, and the 1972 data were presented in the 1973 Hyperion Treatment Plant Technical Report. Computer analyses were performed for this report using the biomass data for the major taxonomic categories for 1972-75 and the species abundance data for 1972, only. It should be noted, however, that the 1972 data may be somewhat atypical since they were collected as the sampling program was being developed (Nagano, 8 November 1976).

Tabulated data from the Hyperion Treatment Plant Annual Reports are presented as computer-drawn time-series density isopleths in Figures III-C-15 through 20 using the data for each year when available from 1971 through 1975. The total biomass of benthos was consistently greatest in the vicinity of the HTP 5-mile wastewater outfall, but apparently was depressed near the end of the HTP 7-mile sludge outfall (Figure III-C-15). Species diversity was always lowest in the area of sludge accumulation at the end


Pacific Palisades
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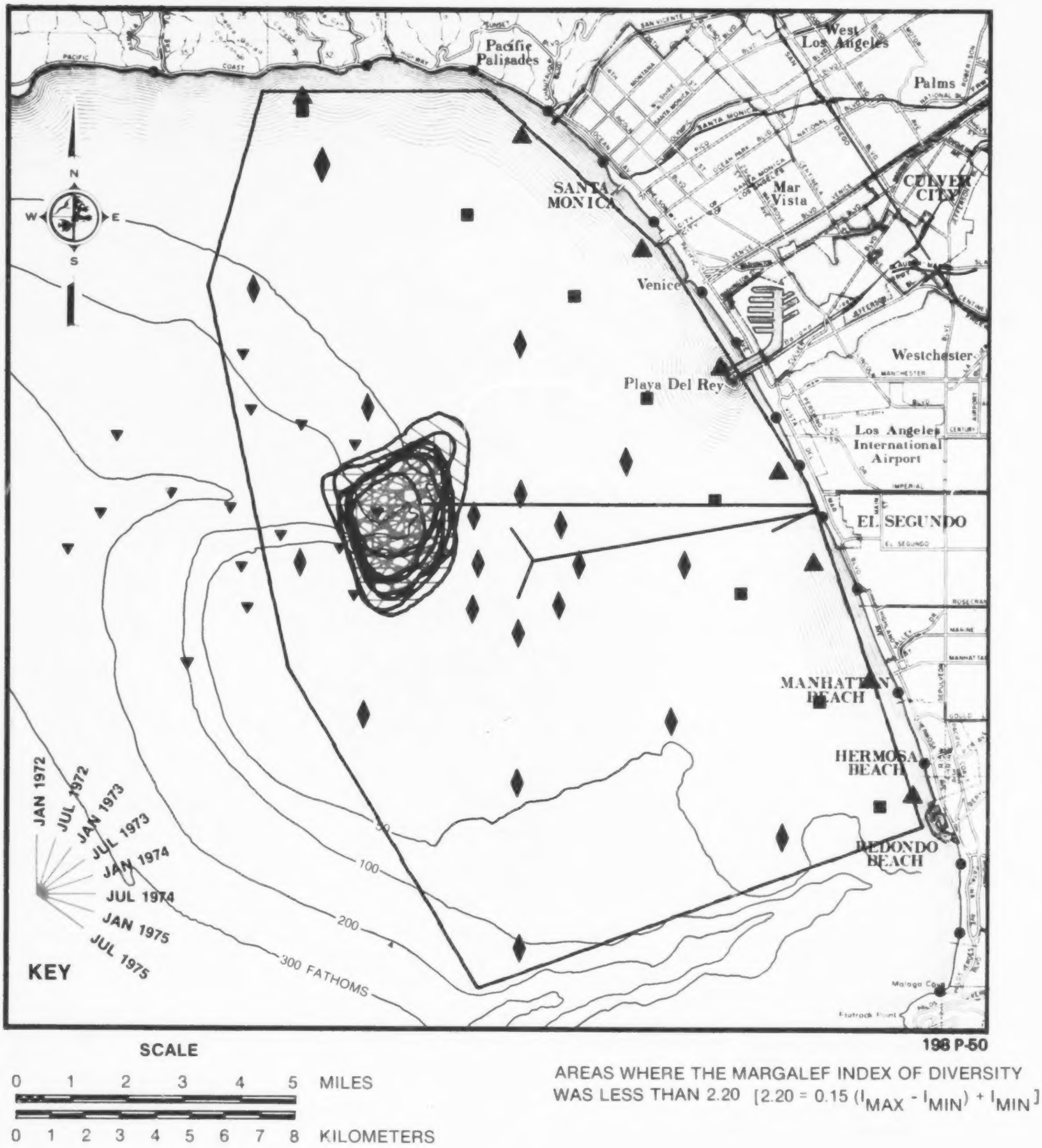
Mar Vista
CULVER CITY
Venice
Westchester
Playa Del Rey
Los Angeles International Airport
EL SEGUNDO
MANHATTAN BEACH
HERMOSA BEACH
REDONDO BEACH
N
S
E
W
JAN 1972
JUL 1972
JAN 1973
JUL 1973
JAN 1974
JUL 1974
JAN 1975
JUL 1975
KEY
50
100
200
300 FATHOMS
198P-277
SCALE
0 1 2 3 4 5 MILES
0 1 2 3 4 5 6 7 8 KILOMETERS
AREAS WHERE TOTAL BIOMASS EXCEEDED 6.86 g/l
[6.86 g/l = 0.85 (CMAX - CMIN) + CMIN]

Figure III-C-15. Areas where the total biomass of benthic organisms exceeded 6.86 g/l for the period January 1972 through July 1975. The contours are computer-drawn (unpublished data from HTP).


Pacific Palisades
West Los Angeles
Palms
SANTA MONICA
Mar Vista
CULVER CITY
Venice
Westchester
Playa Del Rey
Los Angeles International Airport
EL SEGUNDO
MANHATTAN BEACH
HERMOSA BEACH
REDONDO BEACH
N
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S
JAN 1972
JUL 1972
JAN 1973
JUL 1973
JAN 1974
JUL 1974
JAN 1975
JUL 1975
KEY
50
100
200
300 FATHOMS
198 P-50
SCALE
0 1 2 3 4 5 MILES
0 1 2 3 4 5 6 7 8 KILOMETERS
AREAS WHERE THE MARGALEF INDEX OF DIVERSITY WAS LESS THAN 2.20 [2.20 = 0.15 (I MAX - I MIN) + I MIN]

Figure III-C-16. Areas where the Margalef index of diversity was less than 2.20 for the period January 1972 through July 1975. The contours are computer-drawn (unpublished data from HTP). Margalef diversity is an expression of the ratio between the number of species and the number of individuals. A low diversity index value indicates a low number of species in relation to the number of individuals. A low diversity index value has classically been associated with low ecological quality although such a generalization does not apply to all ecological communities. Generally, the higher the diversity index value, the less disturbed the community is.

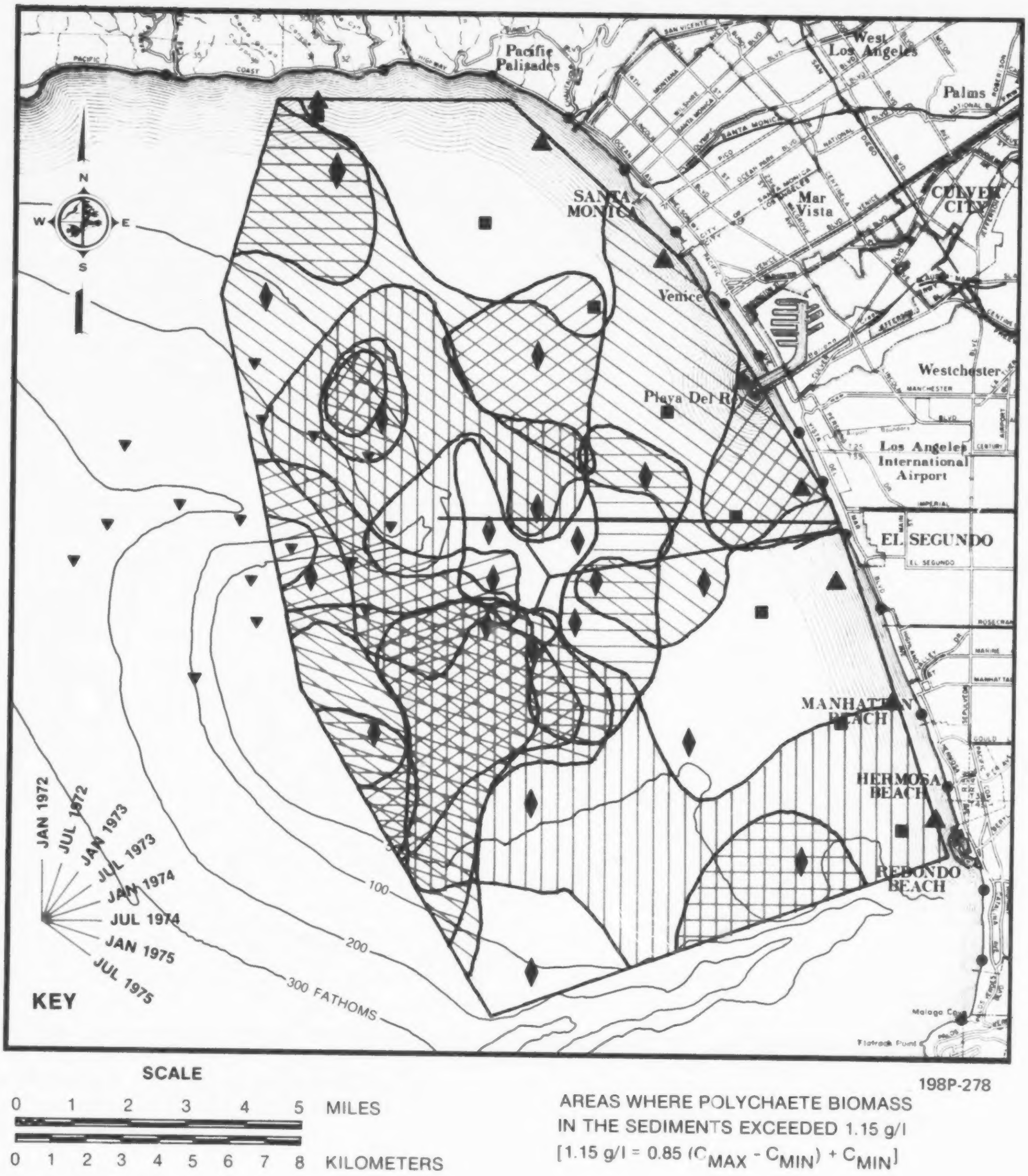

Pacific Palisades
West Los Angeles
Palms
SANTA MONICA
Mar Vista
CULVER CITY
Venice
Westchester
Playa Del Rey
Los Angeles International Airport
EL SEGUNDO
MANHATTAN BEACH
HERMOSA BEACH
REDONDO BEACH
N
S
E
W
100
200
300 FATHOMS
JAN 1972
JUL 1972
JAN 1973
JUL 1973
JAN 1974
JUL 1974
JAN 1975
JUL 1975
KEY
SCALE
0 1 2 3 4 5 MILES
0 1 2 3 4 5 6 7 8 KILOMETERS
198P-278
AREAS WHERE POLYCHAETE BIOMASS IN THE SEDIMENTS EXCEEDED 1.15 g/l
[1.15 g/l = 0.85 (C_MAX - C_MIN) + C_MIN]

Figure III-C-17. Areas where polychaete biomass in the benthic sediments exceeded 1.15 g/l for the period January 1972 through July 1975. The contours are computer-drawn (unpublished data from HTP).

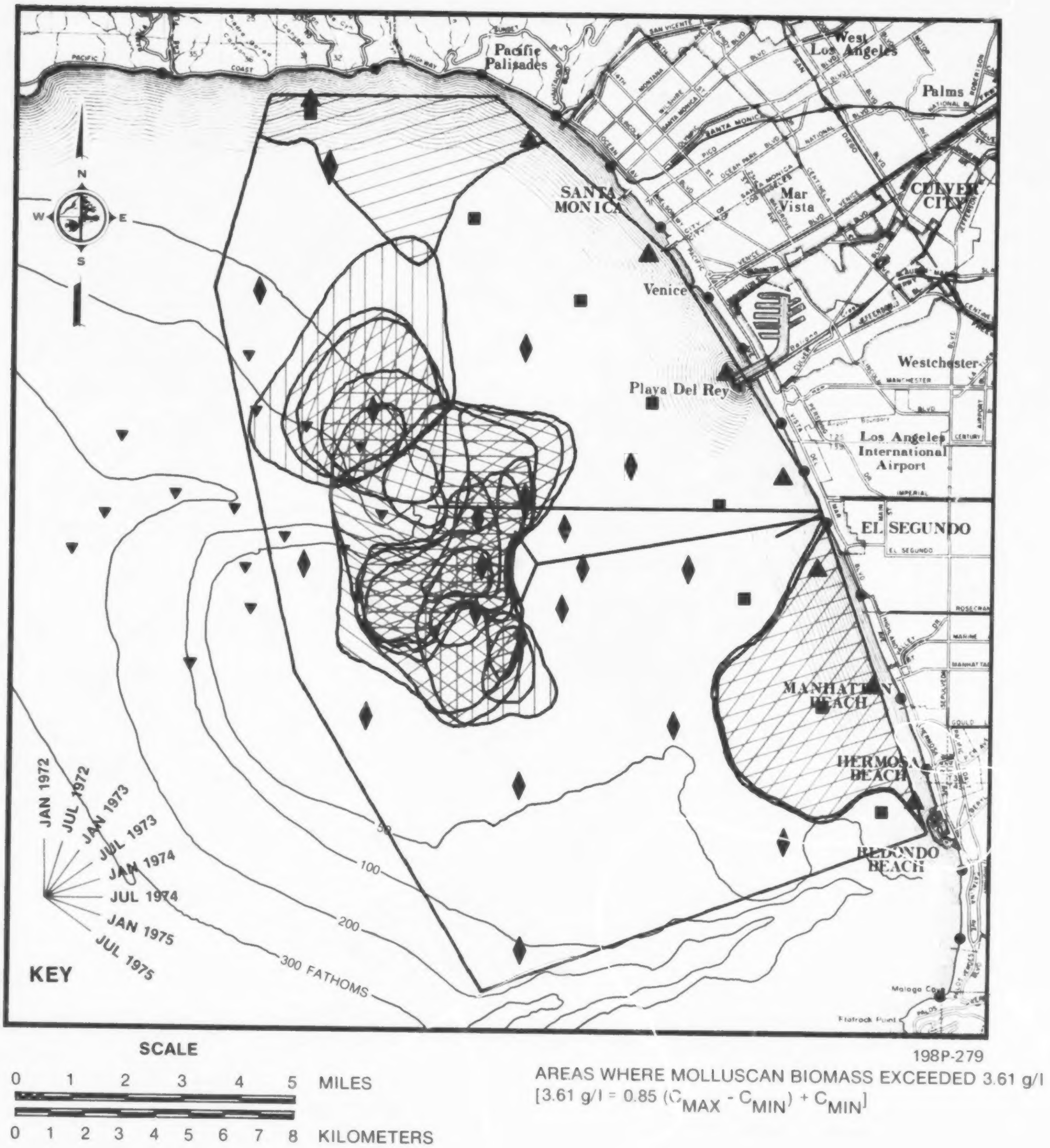
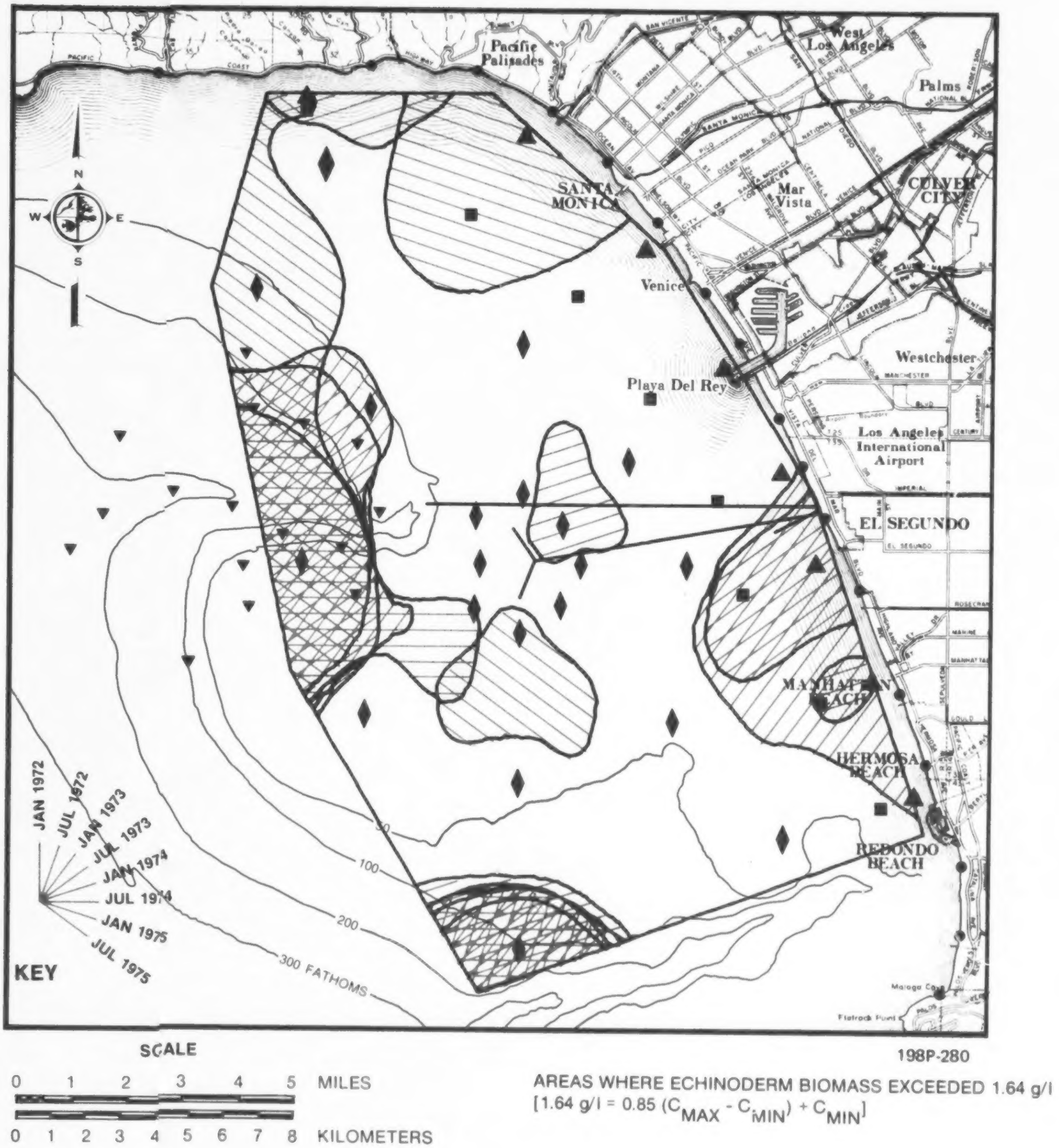

Pacific Palisades
West Los Angeles
Palms
SANTA MONICA
Mar Vista
CULVER CITY
Venice
Westchester
Playa Del Rey
Los Angeles International Airport
EL SEGUNDO
MANHATTAN BEACH
HERMOSA BEACH
REDONDO BEACH
Malaga Cove
Flatrock Point
N
S
E
W
50
100
200
300 FATHOMS
KEY
JAN 1972
JUL 1972
JAN 1973
JUL 1973
JAN 1974
JUL 1974
JAN 1975
JUL 1975
SCALE
0 1 2 3 4 5 MILES
0 1 2 3 4 5 6 7 8 KILOMETERS
198P-279
AREAS WHERE MOLLUSCAN BIOMASS EXCEEDED 3.61 g/l
[3.61 g/l = 0.85 (C_MAX - C_MIN) + C_MIN]

Figure III-C-18. Areas where the molluscan biomass in the benthic sediments exceeded 3.61 g/l for the period January 1972 through July 1975. The contours are computer-drawn (unpublished data from HTP).


Pacific Palisades
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CULVER CITY
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Westchester
Playa Del Rey
Los Angeles International Airport
EL SEGUNDO
MANHATTAN BEACH
HERMOSA BEACH
REDONDO BEACH
Malaga Cove
Flatrock Point
N
S
E
W
50
100
200
300 FATHOMS
KEY
JAN 1972
JUL 1972
JAN 1973
JUL 1973
JAN 1974
JUL 1974
JAN 1975
JUL 1975
SCALE
0 1 2 3 4 5 MILES
0 1 2 3 4 5 6 7 8 KILOMETERS
198P-280
AREAS WHERE ECHINODERM BIOMASS EXCEEDED 1.64 g/l
[1.64 g/l = 0.85 (C_MAX - C_MIN) + C_MIN]

Figure III-C-19. Areas where the echinoderm biomass in the benthic sediments exceeded 1.64 g/l for the period January 1972 through July 1975. The contours are computer-drawn (unpublished data from HTP).

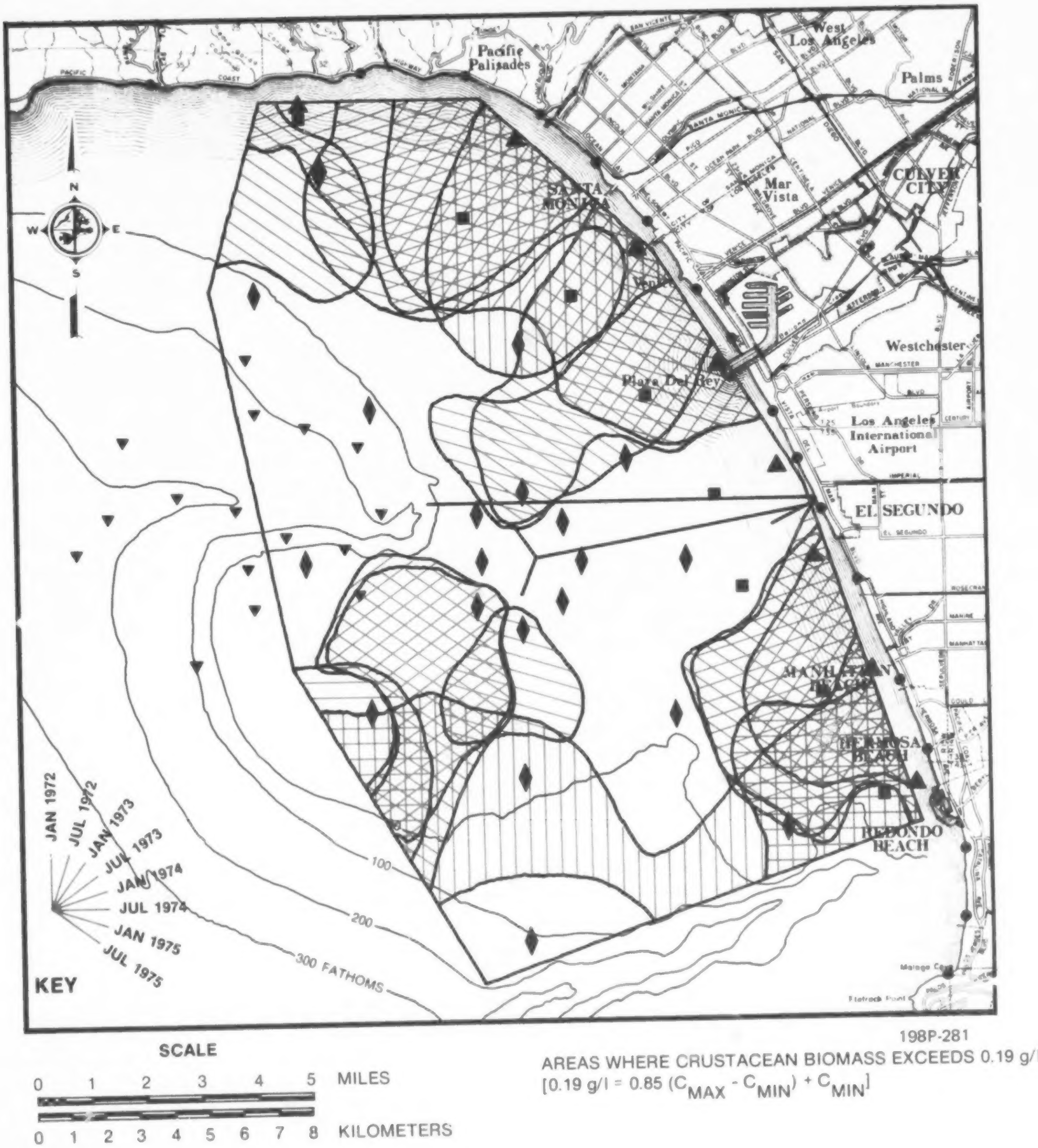
Pacific Palisades
West Los Angeles
Palms
Santa Monica
Mar Vista
Culver City
Venice
Playa Del Rey
Westchester
Los Angeles International Airport
El Segundo
Manhattan Beach
Hermosa Beach
Redondo Beach
Malaga Cove
Flatrock Point
N
S
E
W
100
200
300 FATHOMS
KEY
JAN 1972
JUL 1972
JAN 1973
JUL 1973
JAN 1974
JUL 1974
JAN 1975
JUL 1975
SCALE
0 1 2 3 4 5 MILES
0 1 2 3 4 5 6 7 8 KILOMETERS
198P-281
AREAS WHERE CRUSTACEAN BIOMASS EXCEEDS 0.19 g/l
[0.19 g/l = 0.85 (C_MAX - C_MIN) + C_MIN]

Figure III-C-20. Areas where the crustacean biomass in the benthic sediments exceeded 0.19 g/l for the period January 1972 through July 1975. The contours are computer-drawn (unpublished data from HTP).

of the 7-mile outfall suggesting an environmental stress from the sludge (Figure III-C-16). Overall density of polychaete worms, a group of which the freshwater and pollution tolerant *Capitella capitata* is a member, also was depressed directly at the outfalls but consistently enhanced a few km away from the outfalls (Figure III-C-17), particularly south of the 5-mile outfall where the wastewater plume frequently occurs (Figures III-B-9 and 10). Overall molluscan biomass, on the other hand, was enhanced west of the 5-mile outfall, but not consistently, in the immediate vicinity of either outfall (Figure III-C-18). Echinoderm density (Figure III-C-19) was not enhanced by either effluent and may even be depressed near the outfalls. The density of crustaceans was low immediately around the outfalls and high south of the 5-mile outfall in a pattern (Figure III-C-20) similar to that of polychaetes (Figure III-C-17).

In addition to these semiannual studies, the distribution of a number of organisms identified to the genus or species level in 1972 have been mapped (Figures III-C-21 through 24). In Figure III-C-21, *Capitella capitata* was the only organism to have an enhanced density at the end of the 7-mile outfall. The other three species in this figure have their highest densities to the south or southeast of the 5-mile diffusers where the wastewater plume frequently occurs. The distribution of *Pectinaria californiensis* may also indicate an avoidance of the outfalls as well as an enhancement a short distance from the 5-mile outfall.

The organisms in Figure III-C-22 all have their highest densities near the 5-mile outfall. *Prionospio malmgreni* also has an area of high density near the shoreline north of the outfalls that may be in response to land runoff. All of the distributions show no enhancement in the immediate vicinity of the 7-mile outfall which may or may not indicate avoidance of the sludge, depending on the natural distribution of these organisms.

The organisms in Figure III-C-23 show several distributional patterns in relationship to the outfalls. Ostracod densities appear to have no strong correlation to the outfalls, although the sludge may have some negative effects. The highest densities occurred some distance away and north of the outfalls with surface runoff from land having an influence near shore. *Axinopsida* shows a decrease in abundance in the immediate vicinity of the outfalls and an enhancement away from both outfalls. The distribution of *Tellina bodegensis* indicates enhancement near the 5-mile outfall as well as near the shore (surface runoff) with no apparent effects related to the sludge discharge. *Nephtys* also has its highest density near the 5-mile discharge and shows no effect of the 7-mile outfall.

In Figure III-C-24 *Spiophanes* and *Tanais* show decreased densities in the immediate vicinity of the outfalls, and the highest densities occur just southwest of the 5-mile outfall (also nearshore for *Spiophanes*). The distribution of *Prionospio pygmaeus* shows no apparent relationship to the HTP outfalls. The highest densities are found nearshore, and it may be that this species only occurs in shallow water and thus is not influenced greatly by deep wastewater discharges. *Tellina carpenteri* apparently avoids the immediate vicinity of the outfalls but may be enhanced by the sludge at a distance.

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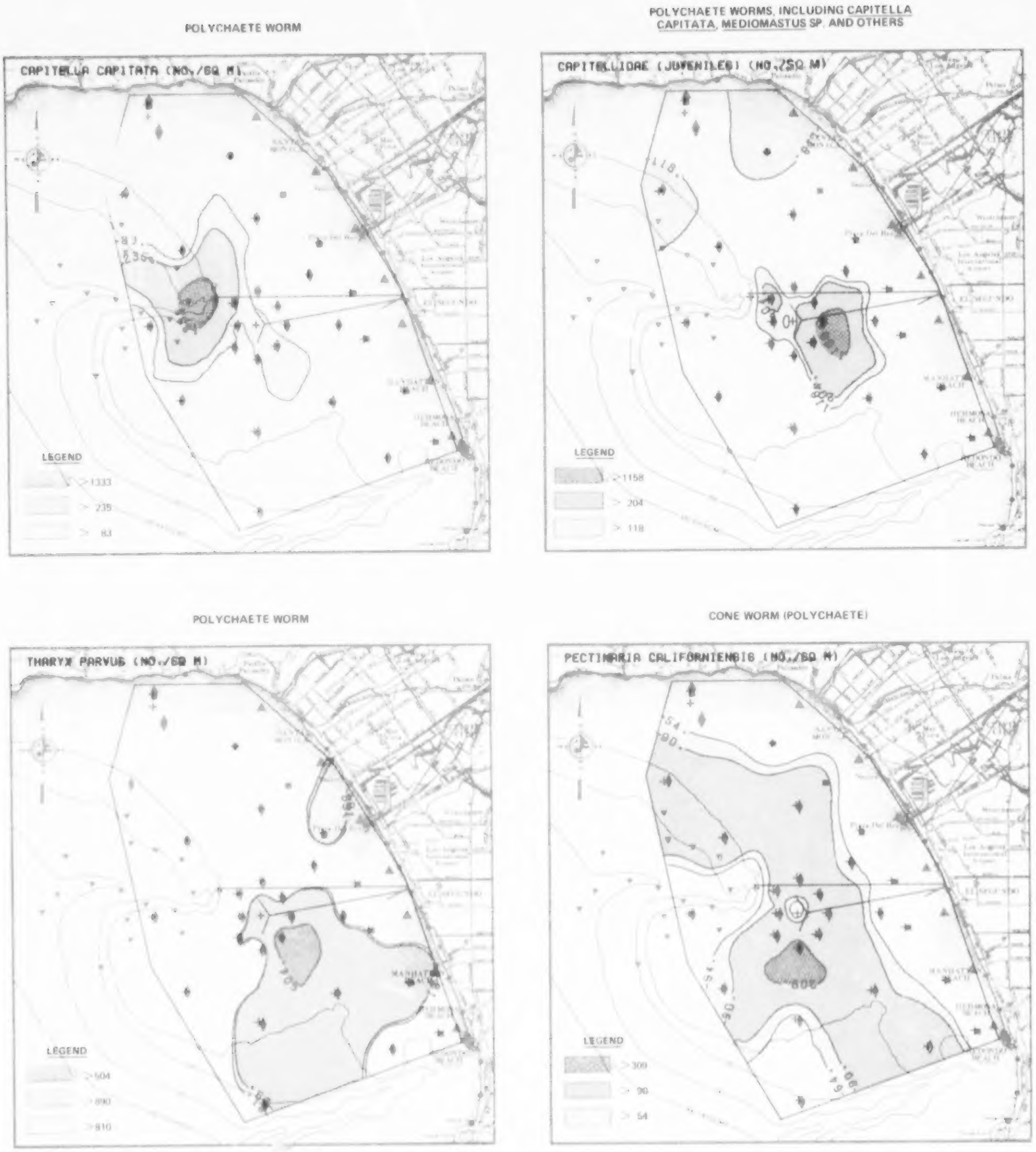
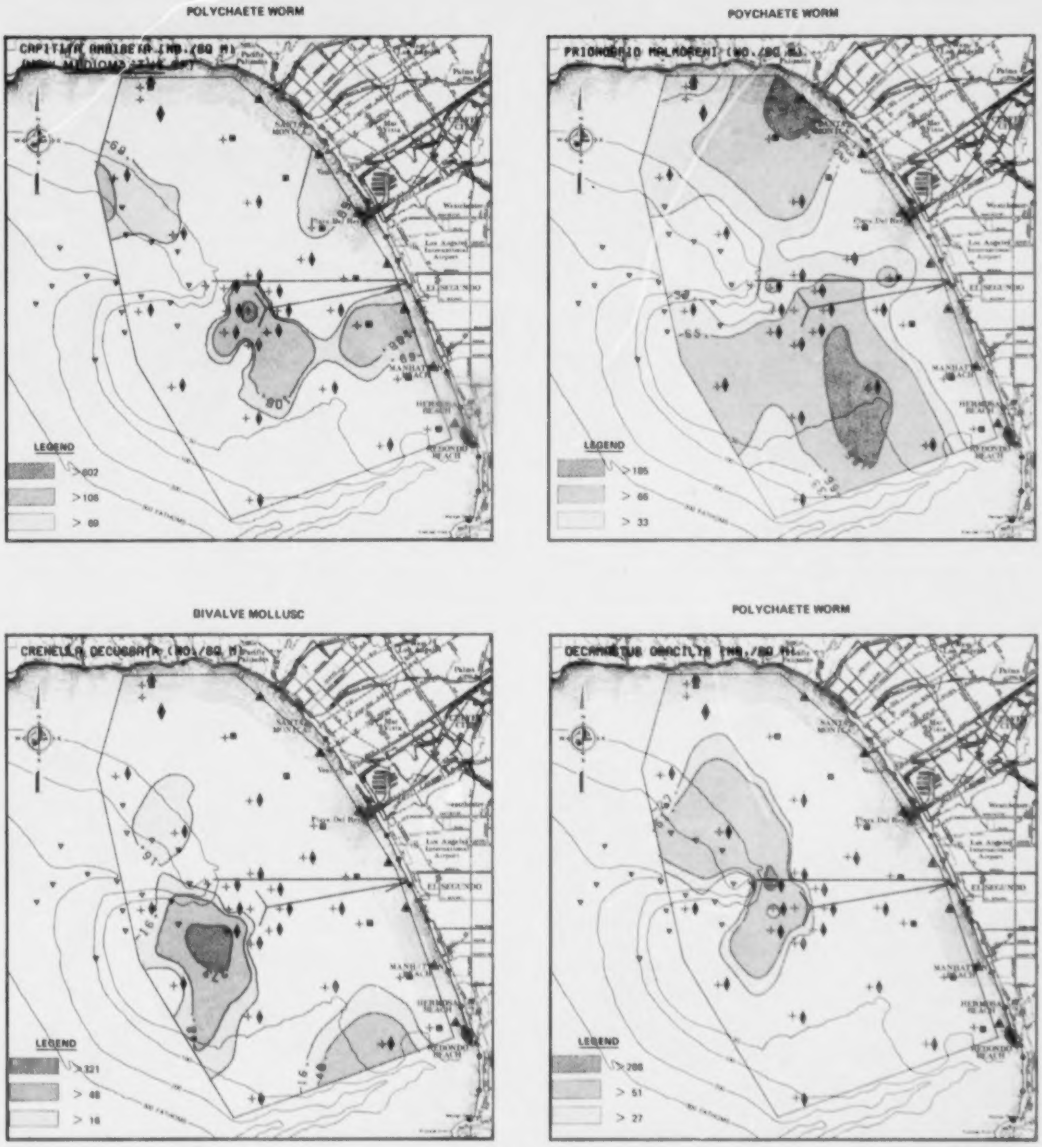

POLYCHAETE WORM
CAPITELLA CAPITATA (NO./SQ M)
LEGEND
>1333
>235
>83
POLYCHAETE WORMS, INCLUDING CAPITELLA CAPITATA, MEDIOMASTUS SP. AND OTHERS
CAPITELLIDAE (JUVENILES) (NO./SQ M)
LEGEND
>1158
>204
>118
POLYCHAETE WORM
THARYX PARVUS (NO./SQ M)
LEGEND
>504
>890
>810
CONE WORM (POLYCHAETE)
PECTINARIA CALIFORNIENSIS (NO./SQ M)
LEGEND
>309
>90
>54

198P-282

Figure III-C-21. Distribution of benthic organisms in the vicinity of the HTP outfalls in January 1972. The locations where samples were taken are shown by a +. The isopleths are computer-drawn at the mean and 15 and 85 percentile density. *Capitella capitata* is enhanced at the end of the 7-mile sludge discharge, whereas the other three species appear to congregate near the 5-mile effluent outfall.


POLYCHAETE WORM
CAPITITA AMBISETA (NO./SQ M)
POYCHAETE WORM
PRIONOSPIO MALMGRENI (NO./SQ M)
LEGEND
>602
>106
> 69
LEGEND
>195
> 66
> 33
EL SEGUNDO
MANHATTAN BEACH
HERMOSA BEACH
REDONDO BEACH
SANTA MONICA
Playa Del Rey
Los Angeles International Airport
BIVALVE MOLLUSC
CRENELLA DECUSSATA (NO./SQ M)
POLYCHAETE WORM
DECAMASTUS GRACILIS (NO./SQ M)
LEGEND
>121
> 48
> 16
LEGEND
>208
> 51
> 27
100 FATHOMS

198P-283

Figure III-C-22. Distribution of benthic organisms in the vicinity of the HTP outfalls in January 1972. The locations where samples were taken are shown by a +. The isopleths are computer-drawn at the mean and 15 and 85 percentile density. These organisms appear to congregate near the 5-mile outfall diffusers (data from DPW, 1973).

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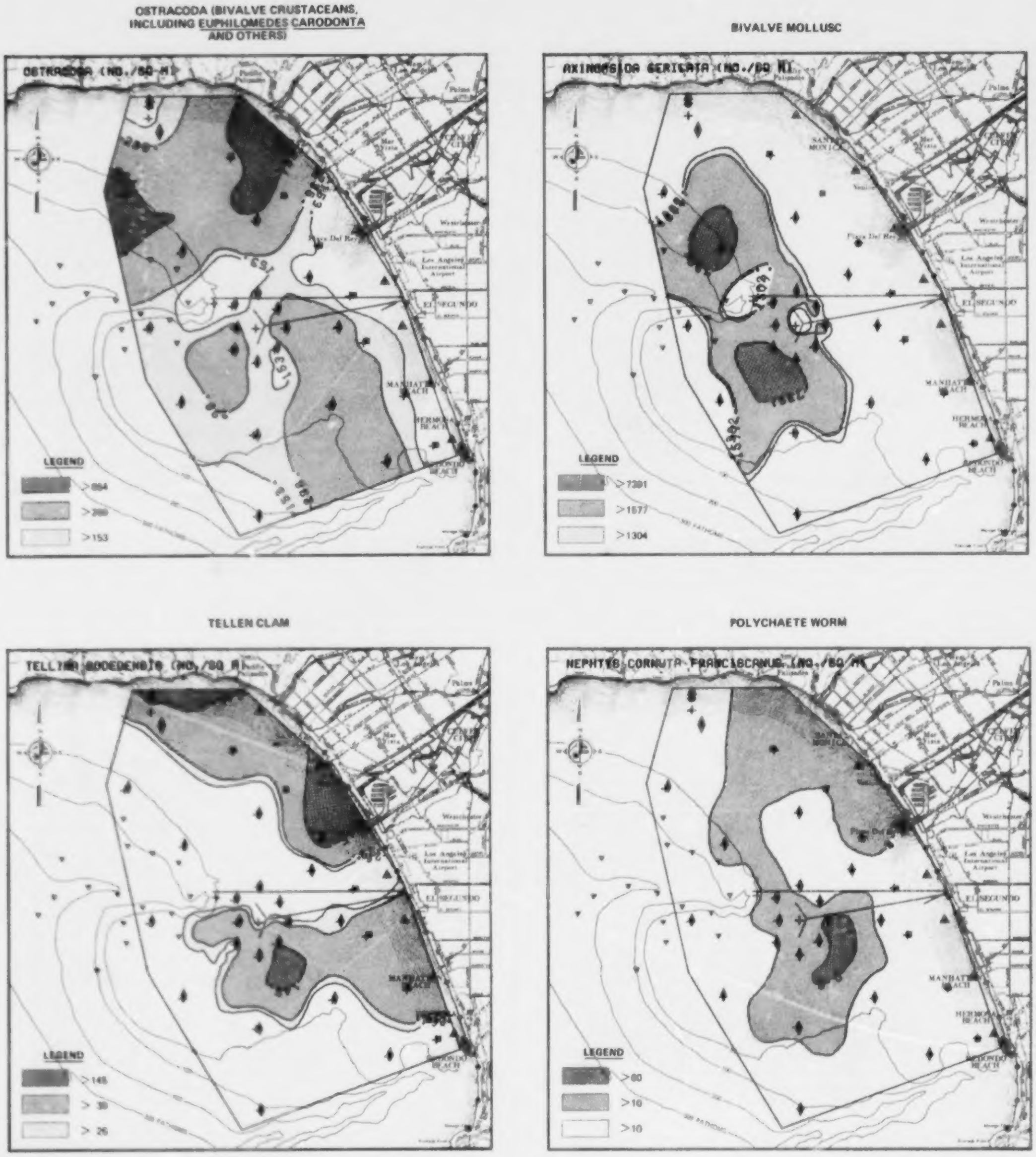
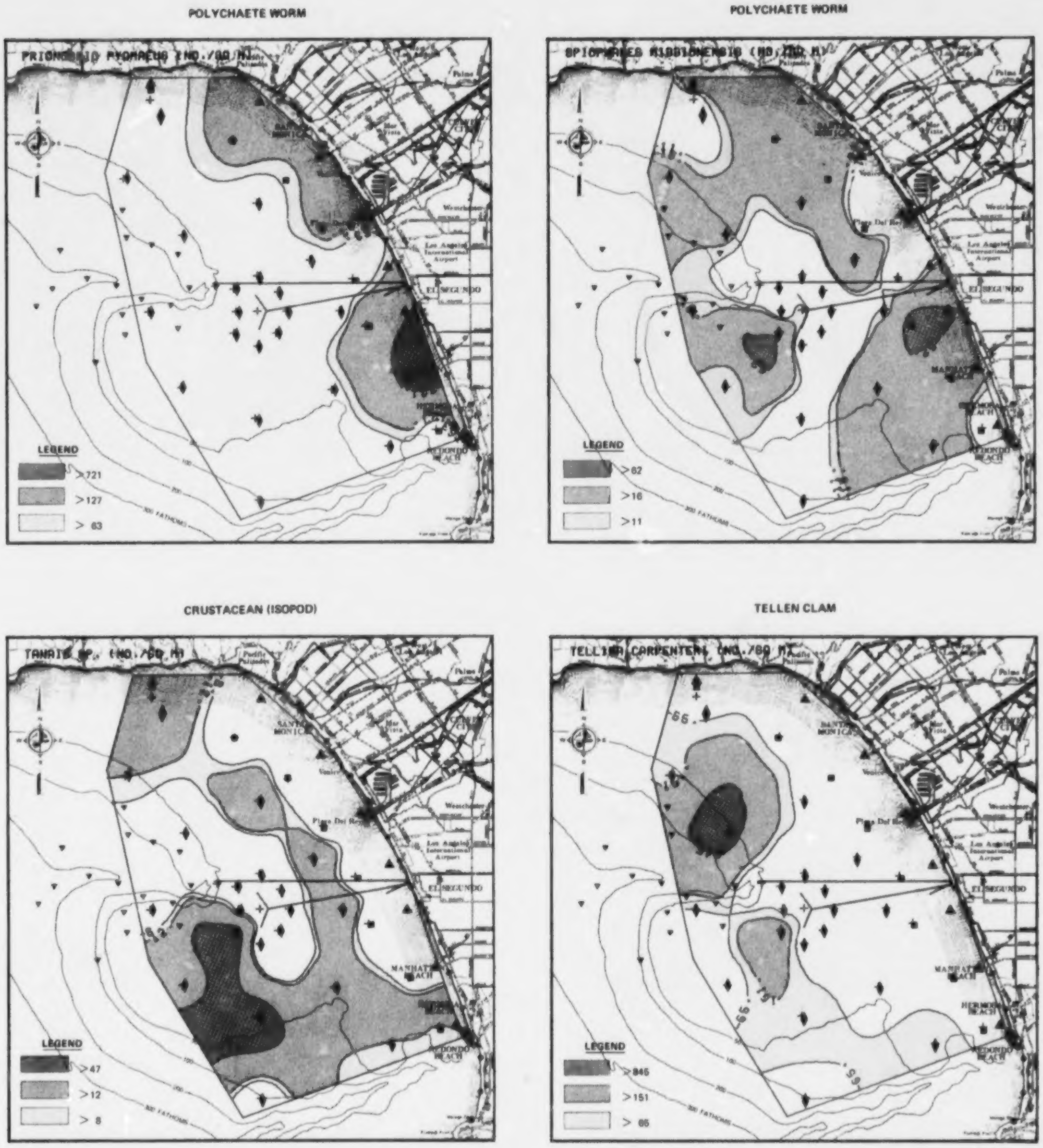

OSTRACODA (BIVALVE CRUSTACEANS, INCLUDING EUPHILOMEDES CARODONTA AND OTHERS)
OSTRACODA (NO./SQ M)
LEGEND
>864
>280
>153
BIVALVE MOLLUSC
AXINOPSIDA SERICATA (NO./SQ M)
LEGEND
>7301
>1577
>1304
TELLEN CLAM
TELLINA BODEGENSIS (NO./SQ M)
LEGEND
>145
> 35
> 26
POLYCHAETE WORM
NEPHTYS CORNUTA FRANCISCANUS (NO./SQ M)
LEGEND
>80
>10
>10
SANTA MONICA
Playa Del Rey
Westchester
Los Angeles International Airport
EL SEGUNDO
MANHATTAN BEACH
HERMOSA BEACH
REDONDO BEACH

198P-284

Figure III-C-23. Distribution of benthic organisms in the vicinity of the HTP outfalls in January 1972. The locations where samples were taken are shown by a +. The isopleths are computer-drawn at the mean and 15 and 85 percentile density. The distribution of *Axinopsida* shows a strong negative relationship to the outfalls while that of *Nephtys* is apparently enhanced near the 5-mile outfall (data from DPW, 1973).



POLYCHAETE WORM

POLYCHAETE WORM

CRUSTACEAN (ISOPOD)

TELLEN CLAM

LEGEND
>721
>127
> 83
LEGEND
>62
>16
>11
LEGEND
>47
>12
> 8
LEGEND
>845
>151
> 65
EL SEGUNDO
SANTA MONICA
Los Angeles International Airport
MANHATTAN BEACH
HERMOSA BEACH
REDONDO BEACH
Westchester
Playa Del Rey
Venice
Palms
300 FATHOMS

198P-285

Figure III-C-24. Distribution of benthic organisms in the vicinity of the HTP outfalls in January 1972. The locations where samples were taken are shown by a +. The isopleths are computer-drawn at the mean and 15 and 85 percentile densities. These organisms show a variable pattern of congregation, with none appearing to be strongly attracted to the outfalls (data from DPW, 1973).

The data presented in Figures III-C-15 through 24 do show some distinct relationship to the HTP outfalls; however, without data for the natural distribution patterns for these organisms prior to the sewage discharges, it is very difficult to ascertain the influence of sewage on the distribution of organisms in the vicinity of the outfalls. Sediment type and depth are important factors in determining the distribution of benthic organisms, and natural variations in these parameters may result in at least some organism distributions that coincidentally show positive or negative relationships to the outfalls.

Another method of presenting the HTP benthos data which attempts to eliminate the effects of depth, or the presence of the continental shelf, on the distribution of organisms, is to select sample points from the existing data in such a way that they come close to being a transect at a constant depth. Mearns et al. (1976) presented the Hyperion Treatment Plant January 1975 data in this manner for the density of annelids, arthropods, molluscs, and echinoderms; for the total numbers of species per sample, the biomass per sample, and the number of individuals per m^2; and for the numerical abundance of three important species.

These data, arranged into transects through the ends of the 7-mile sludge outfall (Figure III-C-25) and the 5-mile effluent outfall (Figure III-C-26), show some striking biological patterns which may be representative of the recent impact of the HTP outfalls on benthos. At the end of the 7-mile sludge outfall there is a clear depression of the number of species per sample, the number of organisms per m^2, the biomass per m^2, the percentage of molluscs in the sample, the density of the polychaete worm, *Tharyx* sp., and the density of the bivalve mollusc, *Parvilucina tenuisculpta*. There is a pronounced increase in the percentage of annelid worms, particularly the pollutant-tolerant polychaete, *Capitella capitata*. The trends are less clear off the 5-mile outfall (Figure III-C-26) which releases a diluted but much more voluminous effluent. There is a clear depression of the density of *P. tenuisculpta* and of the number of organisms per m^2 in bottom sediments.

On both transects there are peaks of some organism densities in the vicinity of but not immediately at the ends of the outfalls. It is difficult to place much confidence in these subsidiary peaks since the sampling stations are too far apart, and because the confounding effect of effluents from both outfalls are difficult to resolve. However, the data do suggest that effluent induced alterations in the water and/or sediments near the outfalls inhibit some groups such as molluscs, particularly *Parvilucina,* while at some distance from the outfalls this inhibition no longer occurs and a relevant enhancement in organism abundance and productivity ensues.

Invertebrate epifauna collected in synoptic, demersal trawls throughout Santa Monica Bay in September 1973 (Mearns and Greene, 1974) showed the following four organisms to be most abundant (presented in order of decreasing abundance): the carid shrimp, *Pandalus jordani;* the sand star, *Astropecten verrilli;* the peneid shrimp, *Sicyonia ingentis;* and the sea pen, *Stylatula* sp. These abundances were not expressed as biomass per unit area, however, because of the qualitative nature of trawl sampling.

As an approach to relating the characteristics of the sediments of Santa Monica Bay to the distribution and abundance of organisms, HDR performed a stepwise multiple regression analysis of total organism abundance and of abundance of 15 benthic species against 25 physical and chemical characteristics of the sediments (concentrations of As, Cd, Cr, Cu, Pb, Ni, Ag, As, Hg, cyanide, phenolic compounds, total chlorinated hydrocarbons, β-activity, biological oxygen demand, and sulfides; the depth; the distance from the outfall; and 6 categories of particle size described as the percent of the sample remaining when sieved through sieve sizes 28, 50, 70, 100, 200, and greater than 200). The data were all taken from 1972 sediment samples reported in the HTP 1973 Technical Report (DWP, 1973). Linear multiple regression yielded 5 dependent variables that were highly significantly correlated ($R^2>0.89$) with sediment characteristics. Table III-C-8 summarizes these results and indicates that the particle size of the sediments was very important in determining distribution of most organisms. Sediment particle size has not yet been analyzed as a dependent variable, but it appears that small particle sizes are generally correlated with the outfall location. Total abundance of organisms was strongly negatively correlated with concentration of chlorinated hydrocarbons; the abundance of *Capitella capitata* was positively correlated with sulfides and copper; the abundance of *Decamastus gracilis* was positively correlated with copper and lead, and negatively correlated with BOD; and *Axinopsida sericata* was also negatively correlated with BOD. The same analyses for data from 1973 to present has yet to be performed.

Table III-C-8. Preliminary results of a multiple regression analysis of benthic species density against physical and chemical sediment characteristics near the Hyperion Treatment Plant outfalls. All data used in this analysis came from the HTP Technical Report (DPW, 1973) and were collected in 1972.

DEPENDENT BIOLOGICAL VARIABLES	MULTIPLE REGRESSION COEFFICIENT, R^2	PHYSICAL SEDIMENT VARIABLES MOST IMPORTANT TO THE REGRESSION AND THEIR SIGN
Total Abundance	.95	+ percent of sample remaining on #28 sieve - TICH
Capitella capitata	.99	+ Sulfides; + Cu; + Percent of sample remaining in #50 sieve
Axinopsida sericata	.94	+ percent of sample remaining in #28 sieve - BOD; - percent of sample remaining in #100 sieve
Decamastus gracilis	.97	- BOD; + Cu; + Pb
Tellina carpenteri	.89	+ Percent of sample remaining on a #70 sieve

NOTE: The parameters listed in the third column indicate the most important physical and chemical qualities of the sediments that have a positive (+) or negative (-) correlation to the variables listed in the first column. The R^2 value for each dependent variable is the fraction of the data points "explained" by the linear regression equation generated from the data.

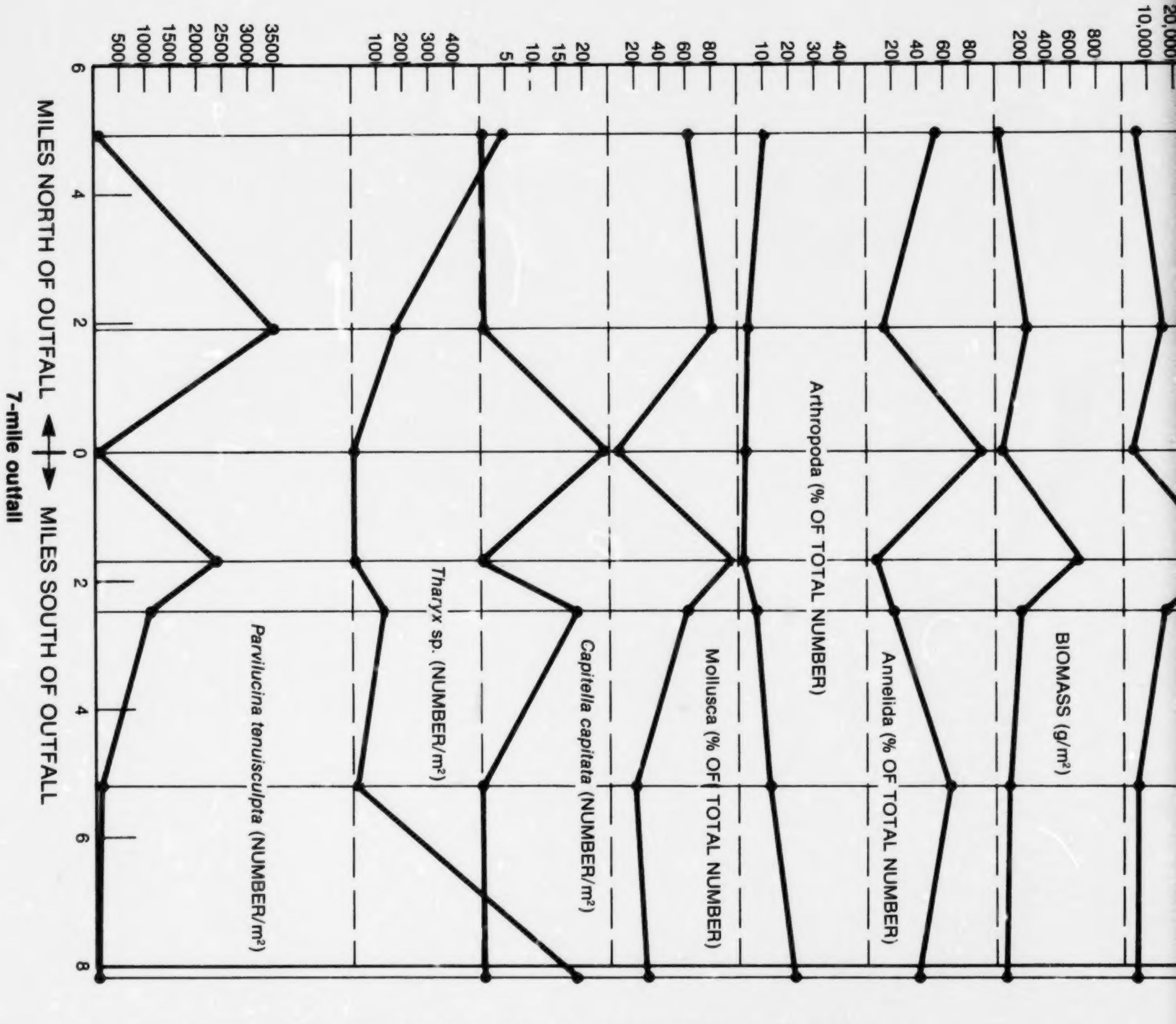
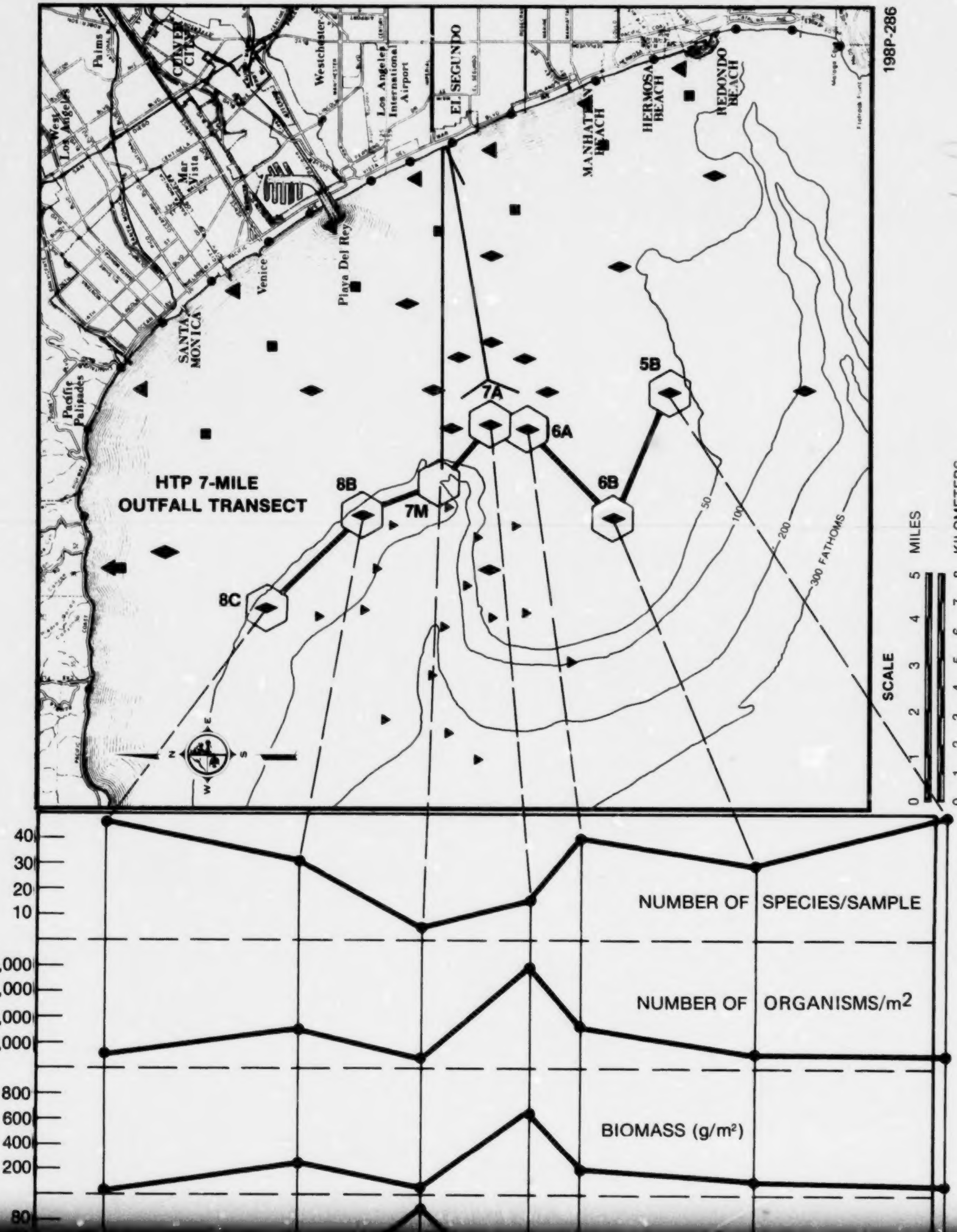


Figure III-C-25. Abundance, biomass, and relative composition of benthic invertebrates collected along a depth contour passing near the end of the HTP 7-mile sludge outfall (data from Mearns et al., 1976).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Playa Del Rey
Westchester
Los Angeles International Airport
EL SEGUNDO
MANHATTAN BEACH
HERMOSA BEACH
REDONDO BEACH
HTP 7-MILE OUTFALL TRANSECT
8C
8B
7M
7A
6A
6B
5B
N
E
S
W
50
100
200
300 FATHOMS
SCALE
0 1 2 3 4 5 MILES
0 1 2 3 4 5 6 7 8 KILOMETERS
198P-286
40
30
20
10
NUMBER OF SPECIES/SAMPLE
40,000
30,000
20,000
10,000
NUMBER OF ORGANISMS/m2
800
600
400
200
BIOMASS (g/m²)
80

/ P.

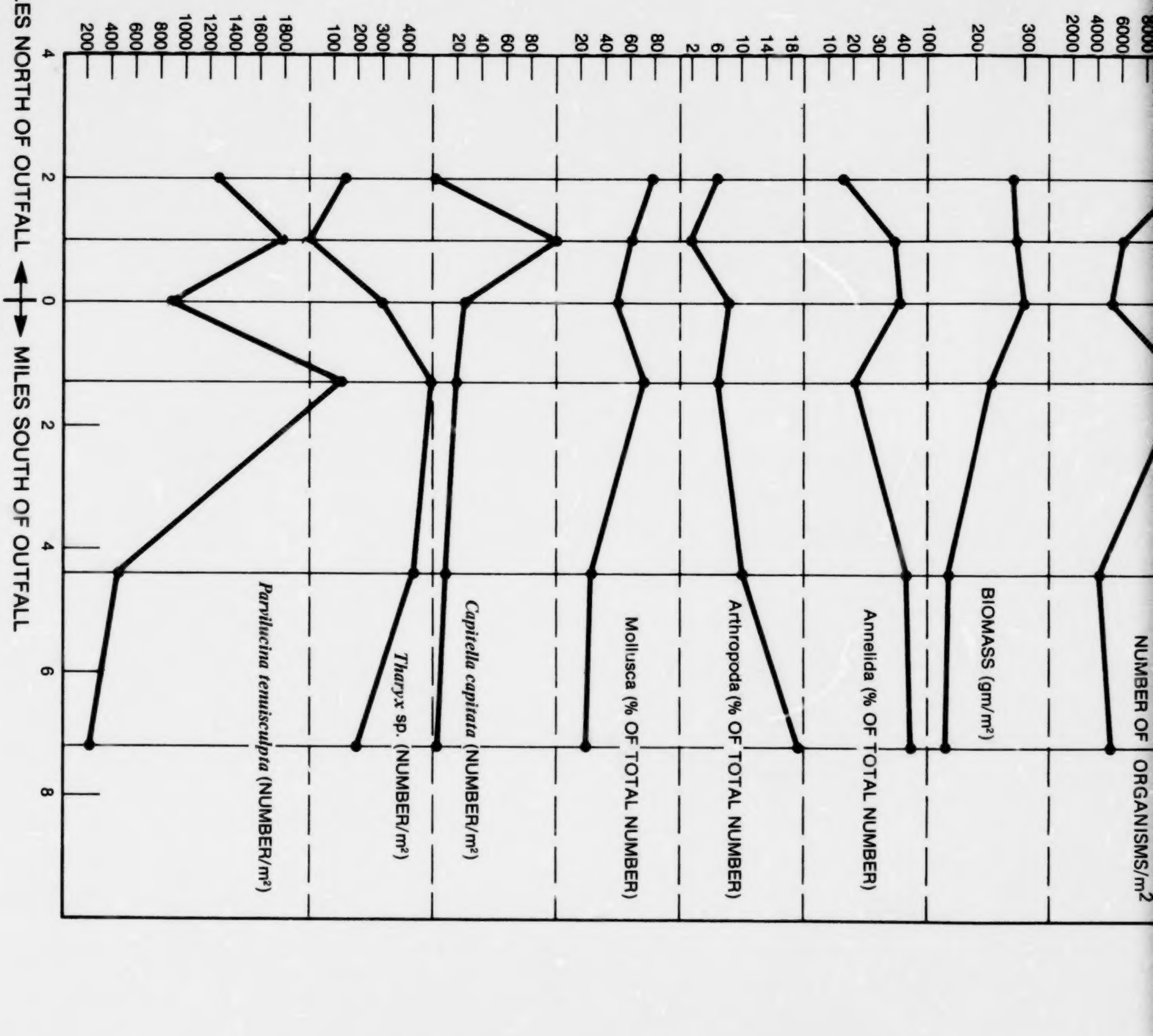
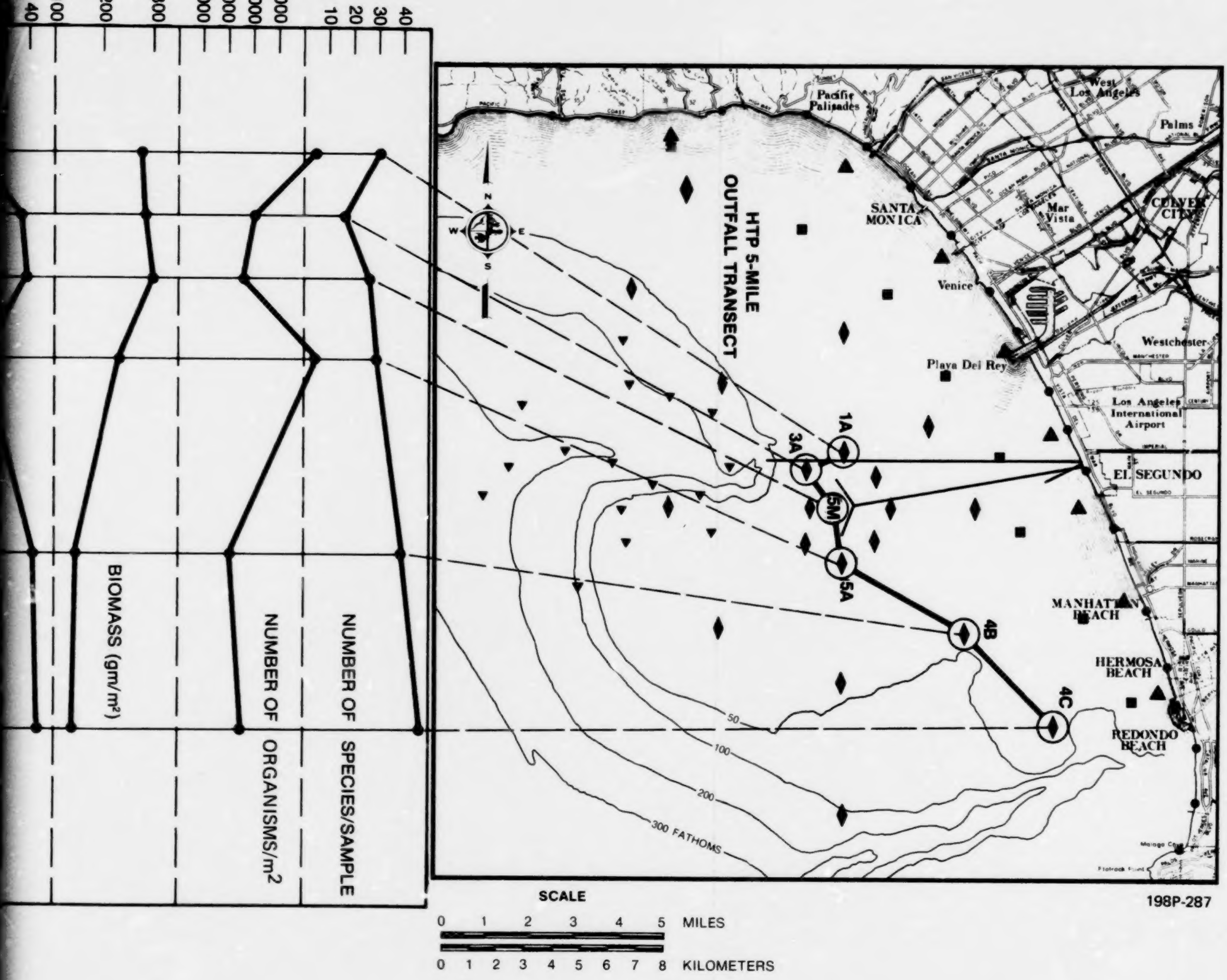


Figure III-C-26. Abundance, biomass, and relative composition of benthic invertebrates collected along a depth contour passing near the diffusers of the HTP 5-mile outfall (data from Mearns et al., 1976).



NUMBER OF SPECIES/SAMPLE
10
20
30
40
NUMBER OF ORGANISMS/m2
2000
4000
6000
8000
BIOMASS (gm/m²)
100
200
300
40
HTP 5-MILE OUTFALL TRANSECT
Pacific Palisades
SANTA MONICA
West Los Angeles
Palms
Mar Vista
CULVER CITY
Venice
Westchester
Playa Del Rey
Los Angeles International Airport
EL SEGUNDO
MANHATTAN BEACH
HERMOSA BEACH
REDONDO BEACH
1A
3A
5M
5A
4B
4C
50
100
200
300 FATHOMS
N
S
E
W
SCALE
0 1 2 3 4 5 MILES
0 1 2 3 4 5 6 7 8 KILOMETERS
198P-287

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(f) Submarine Canyon Benthic Habitats. Several submarine canyons traverse the mainland shelf in the Southern California Bight. Two of these canyons are in Santa Monica Bay, and the Hyperion Treatment Plant outfalls are at the head of the Santa Monica Canyon.

No studies of benthic algae have been found for the submarine canyons in the Southern California Bight, but little or no algae would be expected for several reasons: limited light as a result of depth and shading of the canyon walls, lack of solid substrate in some canyons, and scouring from the periodic transport of sediments down the canyons to the basins.

Canyons act as channels for upwelling, density currents, and the upward and downward movement of organisms. Relative taxonomic composition of organisms in various canyons along the southern California coast is shown in Table III-C-9. Both variety and number of organisms usually decrease with depth (SCCWRP, 1973).

Table III-C-9. Relative taxonomic composition of invertebrates collected in submarine canyons in the Southern California Bight (SCCWRP, 1973).

CANYON	NUMBER OF SAMPLES	PERCENT OF IDENTIFIED SPECIES					NUMBER OF SPECIES IDENTIFIED
		POLY-CHAETES	CRUSTA-CEANS	MOLLUSCS	ECHINO-DERMS	OTHERS	
Hueneme	14	56.6	14.5	14.5	4.4	10.1	159
Mugu	10	47.1	28.1	12.8	5.8	6.2	242
Dume	10	58.2	17.6	13.2	6.6	4.4	91
Santa Monica	15	69.4	8.2	9.4	6.5	6.5	170
Redondo	13	63.1	7.7	18.4	5.9	4.8	168
San Pedro Sea Valley	15	67.9	5.2	11.8	8.0	7.1	212
Newport	16	56.9	14.5	16.4	5.3	6.9	262
Mean		59.9	13.7	13.8	6.1	6.6	(149)

Estimates of standing crop show that canyons are intermediate between the basins and shelf with a mean biomass of approximately 175 g/m^2 (Table III-C-10)(SCCWRP, 1973). The abundances of organisms in the head of Santa Monica Canyon are shown in relation to the HTP outfalls in Figures III-C-15 through 24.

(g) Deep Ocean Basin Benthic Habitats. No benthic algae occur in ocean basins because of the limited light penetration at the depth of the basins. Some basins are heavily populated with animals, but others are relatively impoverished. The impoverished basins, such as the three shallow ones closest to shore (San Pedro, Santa Monica, and Santa Barbara

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Table III-C-10. Estimates of mean biomass of benthic fauna in canyons and basins and along the mainland shelf of the Southern California Bight (SCCWRP, 1973).

CANYONS	BIOMASS (g/m^2)
Hueneme	275
Mugu	154
Dume	145
Santa Monica	43
Redondo	367
San Pedro Sea Valley	88
Newport	151
Mean	175
BASINS	
Santa Barbara	2.8
Santa Monica	4.4
San Pedro	5.5
Santa Cruz	3.2
San Nicolas	5.5
Santa Catalina	8.3
San Clemente	1.5
West Cortez	4.2
Tanner	10.0
Mean	5.0
Mainland Shelf	500 - 4,000

Basins), are characterized by reduced oxygen levels below the sill depth which may account for the lack of organisms. Bacterial decomposition of organic matter settling out from the natural high productivity (compared to offshore) of the nearshore surface waters is the cause of this oxygen depletion. Wastewater discharges along the coast may contribute to this organic matter directly or indirectly. The populated basins include the Catalina, Santa Cruz, San Nicolas, Tanner, and San Clemente Basins and contain an abundance of polychaetes, ophiuroids, holothurians, crinoids, brachiopods, urchins, and sea whips. Figure III-C-27 shows the locations of these basins.

Many species are unique to each basin, probably resulting from physical and, therefore, evolutionary isolation of the respective basins by rises, sills, and submerged mountain ranges. Although the deeper basins are heavily populated, the faunal densities are much lower than

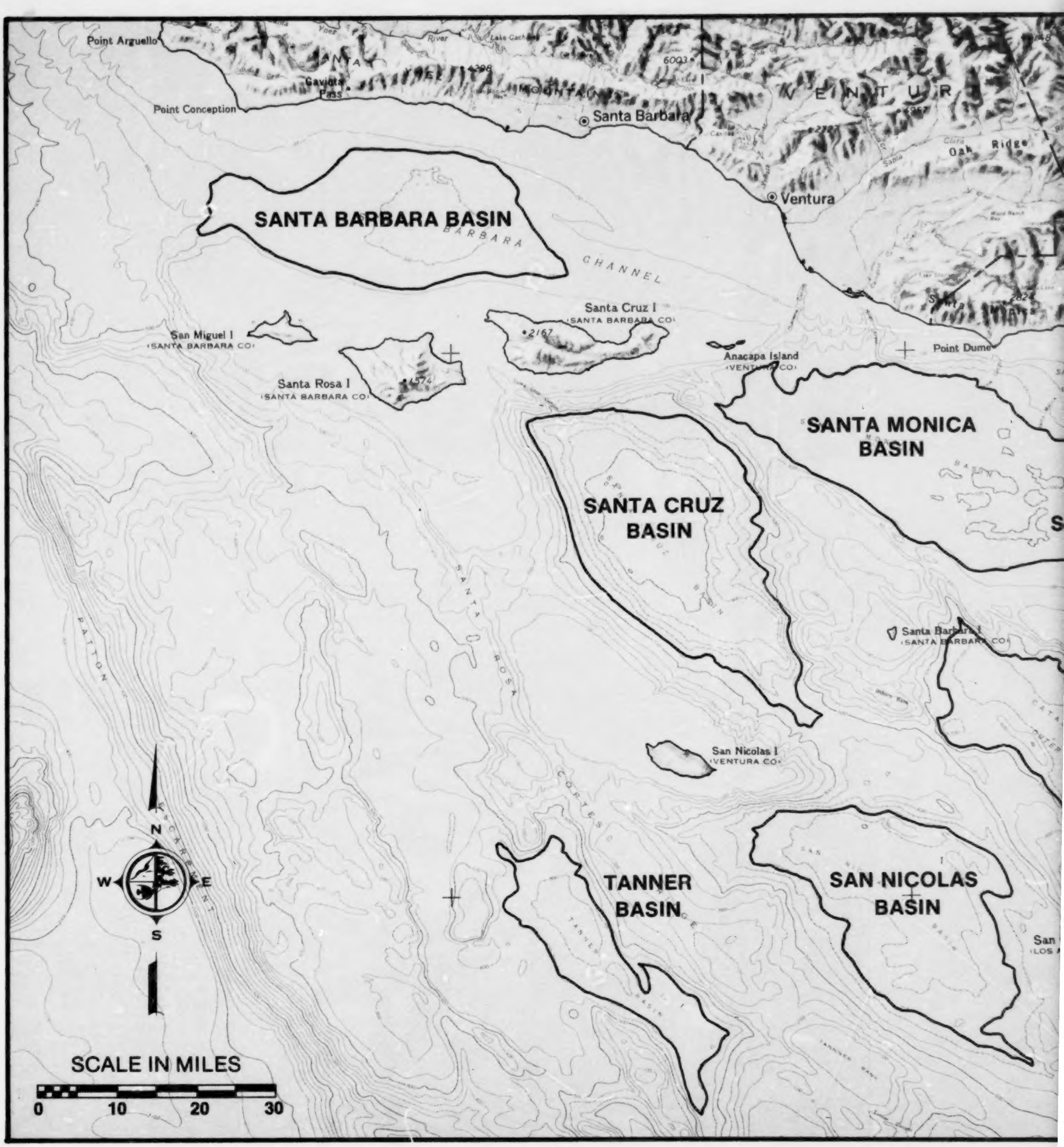
Point Arguello
Point Conception
Gaviota Pass
River
Lake Cachuma
6003
Santa Barbara
Oak Ridge
Ventura
SANTA BARBARA BASIN
BARBARA CHANNEL
San Miguel I
(SANTA BARBARA CO)
Santa Cruz I
(SANTA BARBARA CO)
2167
Santa Rosa I
(SANTA BARBARA CO)
1574
Anacapa Island
(VENTURA CO)
Point Dume
SANTA MONICA BASIN
SANTA CRUZ BASIN
Santa Barbara I
(SANTA BARBARA CO)
SANTA ROSA
CORTES
PATTON
ESCARPMENT
San Nicolas I
(VENTURA CO)
TANNER BASIN
SAN NICOLAS BASIN
N
W
E
S
SCALE IN MILES
0
10
20
30

Figure III-C-27. Ocean basins of the Southern California Bight. Depths are in fathoms.

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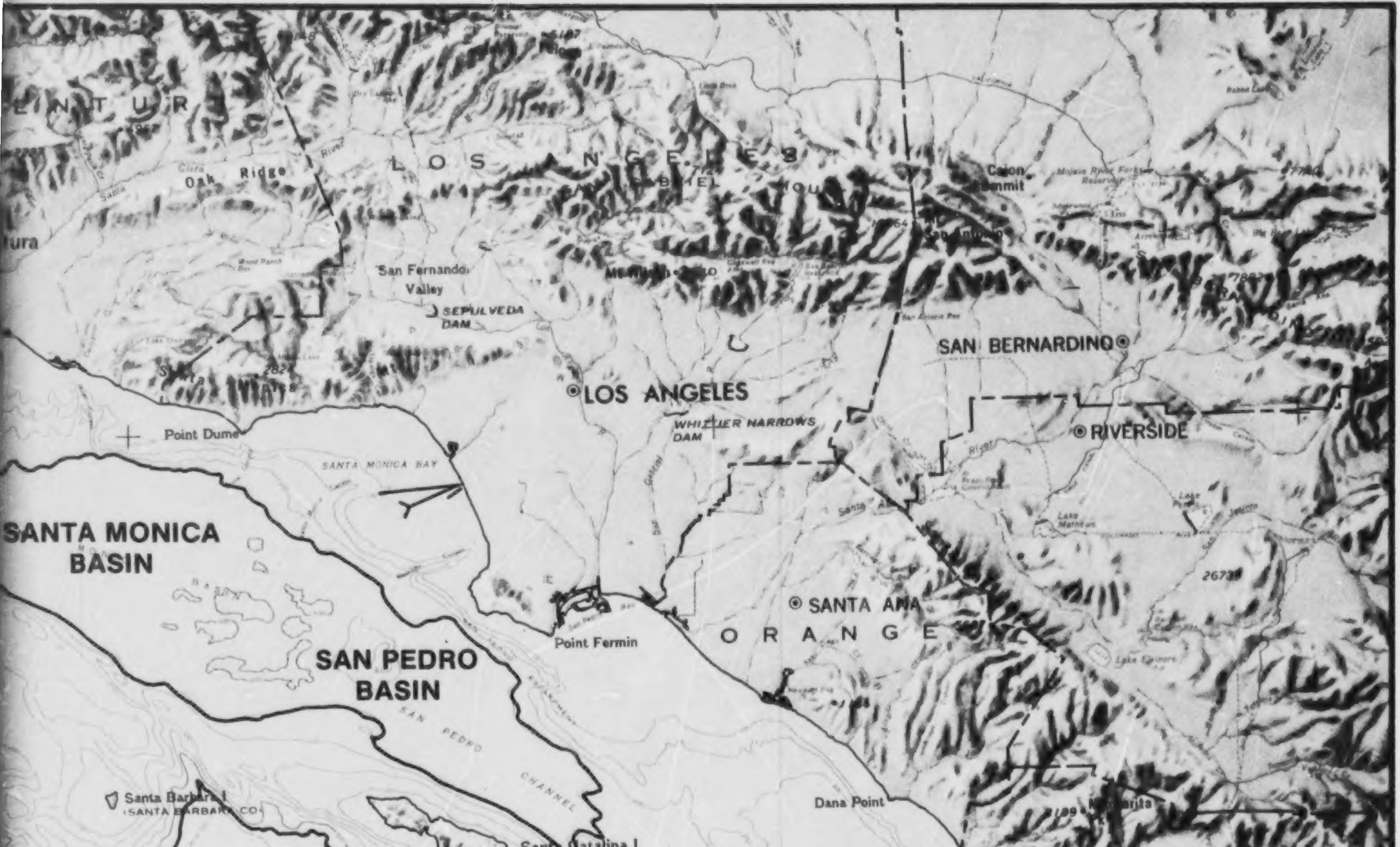
VENTURA
Ventura
Oak Ridge
LOS ANGELES
San Fernando Valley
SEPULVEDA DAM
Cajon Summit
SAN BERNARDINO
LOS ANGELES
WHITTIER NARROWS DAM
RIVERSIDE
Point Dume
SANTA MONICA BAY
SANTA MONICA BASIN
SANTA ANA
ORANGE
Point Fermin
SAN PEDRO BASIN
SAN PEDRO CHANNEL
Dana Point
Santa Barbara I
SANTA BARBARA CO
Santa Catalina I
LOS ANGELES CO
CATALINA BASIN
GULF OF SANTA CATALINA
SAN NICOLAS BASIN
San Clemente I
LOS ANGELES CO
Point La Jolla
SAN DIEGO
Point Loma
SAN CLEMENTE BASIN
SAN DIEGO TROUGH

those occurring on the mainland shelf (Table III-C-10). Appendix III.B lists common and characteristic species found in the basin regions of the Southern California Bight.

Table III-C-11 gives a comparison of the numbers of taxa of various groups identified in samples from ocean basins and from the mainland shelf. Many taxa were not identified to species, and these numbers undoubtedly underestimate the number of species present. There are 4.6 times as many taxa on the mainland shelf as in the basins. Polychaetes include by far the most species in basins comprising 53 percent of the taxa. On the mainland shelf polychaetes comprise 35 percent of the taxa, and crustaceans and molluscs comprise 28 and 29 percent. In basins, 62 percent of the organisms collected are polychaetes, 8 times as many as crustaceans, while approximately equal numbers of polychaetes and crustaceans were collected on the shelf.

Table III-C-11. Number of taxa and percentage of the total sample represented by groups of organisms in Pacific Ocean basins and on the continental shelf (modified from BLM, 1975).

TAXONOMIC GROUP	BASINS[1]			SHELF[2]		
	NUMBER OF TAXA		PERCENTAGE OF TOTAL SAMPLED BY INDIVIDUAL ORGANISMS	NUMBER OF TAXA		PERCENTAGE OF TOTAL SAMPLED BY INDIVIDUAL ORGANISMS
	NUMBER	PERCENT OF TOTAL NUMBER		NUMBER	PERCENT OF TOTAL NUMBER	
Polychaetes	172	53	62	523	35	36
Crustaceans	32	10	8	419	28	35
Molluscs	50 (est)	16	10	408	29	12
Echinoderms	17	5	5	64	4	14
Others	50 (est)	16	15	59	4	3
Total Taxa Identified	321			1,473		

[1] Hartman and Barnard, 1960.

[2] Jones, 1969.

(2) THE EXISTING FISHERY FOR BENTHIC ORGANISMS.

(a) Commercial Fishery.

- Kelp and Related Algal Resources. Dense stands of the giant kelp, *Macrocystis* spp., are harvested regularly along the coast of southern

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California (BLM, 1975). Harvesting is limited to 1.2 meters (4 ft) below the water surface to protect this resource. The harvest from Santa Monica Bay is low, however, since the Bay has always been relatively devoid of these kelp beds. Other benthic algae of commercial value, such as agar weed (*Gelidium* spp.), do not occur in economically harvestable quantities near the Hyperion Treatment Plant outfalls and are therefore not discussed in this report.

- Spiny Lobster. One of the most sought-after shellfish in the Southern California Bight is the California spiny lobster, *Panulirus interruptus*. This crustacean is highly prized for the texture and flavor of its telson meat and has been over-fished (BLM, 1975). Lobsters are collected commercially by trap at depths averaging 18 meters (60 feet) along the coast from Monterrey Bay, California to Magdalena Bay, Baja California. Lobsters grow slowly, reaching a legal size of 8.25 cm (3.25 inches) in carapace length after 10 to 11 years. The considerable illegal catches of undersized "shorts" have contributed to the lobster fishery decline. From 1936 to 1951 lobster catches in California averaged 589,680 kg/yr (1,300,000 lbs/year) declining 77 percent between 1968 and 1973 to only 136,080 kg/year (300,000 lbs/year)(BLM, 1975). Recent economic values (1968-1972) have ranged from $93,000 to $272,000 per year. Lobster brought into Los Angeles between 1968 and 1972 averaged about one-third the total California catch (BLM, 1975).

- Abalone. Most of the commercial catch of abalone in the Southern California Bight consists of five species: *Haliotis rufescens* (red), *H. corrugata* (pink), *H. sorenseni* (white), *H. fulgens* (green), and *H. cracherodii* (black). Abalones live on solid substrates and are usually found in close association with kelp (*Macrocystis* spp. and other large brown algae) beds which they utilize for food. About five to eight years are required for abalone to reach legal commercial size.

Harvesting of abalone is accomplished only by diving, and harvest of these marine gastropods in California has decreased from about 2,041,200 kg/year (4,500,000 lbs/year) for the period 1957 to 1962 to 1,531,807 kg/year (3,377,000 lbs/year) between 1968 and 1973. The catch brought into Los Angeles decreased from 708,977 kg/year (1,563,000 lbs/year, $372,000) in 1968 to 283,046 kg/year (624,000 lbs/year, $190,000) in 1972. It has been speculated that increased consumer demands, illegal-size collections, decreased habitats, and poor water quality around sewage and industrial outfalls may have contributed to the decline of abalone populations (BLM, 1975).

- Other Edible Shellfish. The total weight of rock crabs, *Cancer anthonyi* and *C. antennarius,* caught out of Los Angeles between 1968-1972 ranged from 104,328 to 283,500 kg/year (230,000 to 625,000 lbs/year) and sold for $30,000 to $92,000 (BLM, 1975). Octopuses and other miscellaneous molluscs have also been brought into Los Angeles in small quantities by fishing fleets. Sea urchins, *Strongylocentrotus* spp., have been collected by Santa Barbara commercial fishermen and may be utilized by Los Angeles operations, also.

- Bait Shellfish. In-shore bait shellfish landings from bays and intertidal regions of the Los Angeles area for 1972 included the jacknife clam (*Solen rosaceus, Solen* spp., and *Tagelus* sp.)(20,866 kg, $31,000), purple clam (*Sanguinolaria mittallii*)(644 kg, $810), sand crab (*Emertia analoga*)(3,080 kg, $20,800), shore crab (*Pachygrapsus crassipes*)(11 kg, $5), bay and rock mussels (*Mytilus edulis* and *M. californianus*)(458,136 kg, $17,000)(BLM, 1975). Although monetary values of these bail shellfish were low compared with edible shellfish, the weight landed was comparatively high, particularly considering the large numbers of these small sized organisms that made up the catches (BLM, 1975).

(b) Recreational Fishery.

- Recreational Shellfish Catch. Many of the same shellfish collected commercially are also harvested by sport fishermen. However, certain other organisms are limited to collection by noncommercial interests, only. In the Los Angeles - Santa Monica Bay area, shellfish most avidly sought-after by sportsmen are the spiny lobster, abalone, and rock crabs. Other shellfish not commercially important, but taken privately are the rock scallop (*Hinnites giganteus*) and the smooth California Venus clam (*Chione fluctifraga*). Between 1965 and 1970, 84,000 divers from party boats along the southern California coast collected between 108,000 and 118,000 abalone, 24,000 to 34,000 spiny lobsters, and 20,000 to 30,000 rock scallops. There are no data for private boat and shoreline divers (BLM, 1975).

(3) TOXICITY, UPTAKE, AND BIOACCUMULATION OF SEWAGE CONSTITUENTS IN BENTHIC ORGANISMS. There is little information regarding uptake and effect of toxic substances in benthic plants. Boush and Natsumura (1973) described the process of pesticide degradation by marine algae. It is very likely that industrial and domestic wastewater discharges have affected kelp in the past; however, field observations of kelp (*Macrocystis*) transplanted to locations near the Point Loma and JWPCP outfalls showed no apparent toxic effects of the effluents (SWQCB, 1964). In addition, kelp grows within 305 m (1000 ft) of the Santa Barbara outfall (mainly domestic wastes) and is apparently quite healthy, although the discharge has decreased water clarity somewhat. The plants survive in more turbid water by translocation of nutrients synthesized in the surface canopy to the lower parts of the plant. Laboratory studies showed that Point Loma sewage diluted 1:10 with sea water reduced photosynthesis and damaged young kelp blades in 42 hours while 1 percent sewage caused a distinct stimulation in phtosynthesis over a 15-day period. Further studies in the laboratory showed the toxic levels of wastewater constituents to be 0.1 ppm for Cu^{+2}, 10 ppm for Cr^{+6}, 0.1 ppm for Hg^{+2}, 13 ppm for Zn^{+2}, 1 ppm for Ni^{+2}, > 94 ppm for phenols, 0.5 ppm for chlorinated phenols, 100 ppm for diesel oil, and no effect for Pb. JWPCP effluent diluted to 2, 1, and 0.5 percent did not measurably reduce phtosynthesis in kelp blades during a 2 to 6-day exposure and were even stimulated in some cases.

There is considerable evidence that metals are accumulated by benthic fauna from water, sediments, and food organisms. Benthos in general (Klemmer et al., 1973), and spcifically the red abalone (Anderlini, 1974), concentrate high levels of mercury, especially between Long Beach and La Jolla where the pollution input is high. Similarly, the bay mussel (*Mytilus edulis*) (Schulz-Baldes, 1973), and the common barnacle, *Balanus balanoides*, (Ireland, 1974), concentrate lead from water containing elevated metal levels. Crabs had the highest arsenic concentrations of any benthic invertebrates collected from the Pacific coast of Canada, accumulating tissue levels as high as 37.8 mg/kg (wet weight)(LeBlanc et al., 1973). The mussels, *Mytilus galloprovincialis,* concentrated cadmium 160 times over ambient water levels and retained the accumulated metal for a relatively long time after ambient levels were greatly reduced (Fowler and Benayoun, 1974). When the dog whelk was transferred from clean to polluted water habitats, accumulation of cadmium, cobalt, and zinc resulted in equivalent body concentrations in the new residents and in the native molluscs within 2 to 4 months (Stenner and Nickless, 1974).

Bay mussels from San Pedro, Newport, and San Diego Harbors were also tested for uptake of various metals (SCCWRP, 1975a). These included copper, chromium, nickel, and zinc. Only the data for copper indicated a decreasing gradient of metal concentration in mussel digestive glands from within San Diego and Newport Bays to coastal control stations. In San Pedro Bay, however, copper levels in mussel tissue were found to barely exceed background. Samples collected near the submerged Whites Point outfall (JWPCP), on the other hand, showed three to four times the values measured in San Pedro Harbor. Vessel antifouling paint probably contributed to the high copper levels in mussels from Newport and San Diego Harbors, and neither submarine discharges of municipal wastewater near those localities nor in San Pedro Harbor appear to cause elevated metal levels in adjacent specimens. The reverse seemed to be true for mussels collected in the Whites Point vicinity because of the high local copper waste discharged from JWPCP. Although these mussels may be excellent indicators of metal contamination, little is known of any damaging effects to natural mussel populations or to other biota.

Pesticides and related compounds like PCB's are accumulated in the tissues of benthic fauna. In 1971 SCCWRP surveyed the levels of DDT and PCB's in certain intertidal organisms to ascertain the distribution of the chlorinated hydrocarbons throughout the Bight. The selected species were the intertidal mussel, *Mytilus californianus* (a phytoplankton filter feeder), the gooseneck barnacle, *Pollicipes polymerus* (which filter feeds or grasps small zooplankters from surf zone), and a few starfish specimens, *Pisaster* spp. (which feed on both the mussel and the gooseneck barnacle and represent a higher step in the food chain). The highest concentrations of DDT in mussels, 4.0 and 4.2 ppm, were found on the Palos Verdes peninsula and decreased north and south along the coast. Similarly, the highest concentrations of PCB's, 0.38 and 0.53 ppm, occurred in mussels collected off Palos Verdes. The results for the barnacles and the starfish were not presented in the 1973 SCCWRP report. SCCWRP (1974) removed mussels from Palos Verdes and suspended them at the intertidal level in La Jolla where seawater concentrations of DDT and PCB's are lower. An analysis showed that 42 percent of the DDE (degradation product of DDT) originally in the organism was lost in 11 days.

Mussel tissue collected along the southern California coast, especially in the Whites Point vicinity, has reflected decreases in the input of total DDT to coastal ecosystems. Total DDT at Point Vicente decreased 84 percent between 1971 and 1974 (SCCWRP, 1975a). The high concentrations of PCB's (especially Aroclor 1254) observed in mussels collected at Palos Verdes in 1971 decreased by 73 percent in specimens collected in 1974 (SCCWRP, 1975a). Decreases of 54 percent for Aroclor 1254 were also noted at Point Loma over the same time interval.

(a) DDT and PCBs in Edible Mussels Near Sewage Outfalls. In 1974, SCCWRP (1975a) suspended mussels (*Mytilus californianus*) at various levels in the water column for 14 weeks off Palos Verdes near the JWPCP outfall to determine rates of uptake of PCB's and to attempt to correlate PCB uptake with depth. The results showed cyclic fluctuations of PCB levels with time at all depths and a gradient of uptake with the greatest PCB uptake near the bottom. In January and February of 1976 similar experiments to analyze uptake of both DDT and PCB's were performed by SCCWRP in the water column 1 km north of the end of the Hyperion 7-mile outfall in Santa Monica Bay, near the JWPCP diffusers off Palos Verdes, and near the Orange County Sanitation District diffuser off Newport. These previously unpublished data are shown in Figures III-C-28 and 29. Each data point represents DDT or PCB levels in a pooled sample of five mussels.

Mussels that were uncontaminated with PCB's or DDT were utilized for these experiments. Tissue levels of DDT were an order of magnitude higher off the JWPCP outfall than near the Hyperion outfall. Furthermore, tissue levels of DDT in mussels living on the Santa Monica Pier were 25 percent higher than the highest level observed near the Hyperion outfall, and maximum tissue levels of PCB's were comparable on the Pier and near the outfall.

It may be concluded from these studies that all three outfalls (or the sediments in their vicinities) are releasing DDT and PCB's to the water column in concentrations that can be taken up by organisms, and that the concentrations are smaller near the Hyperion outfall than near the JWPCP outfall off Palos Verdes. It appears that the spatial distribution of biologically available DDT and PCB's around the Hyperion outfalls could be monitored using this technique at points on a standard sampling grid.

(b) Chlorinated Hydrocarbons in Edible Crabs. The market crab, *Cancer anthonyi*, is a scavenger that feeds on bottom material which may be heavily contaminated. Chlorinated hydrocarbon concentration in the muscle and gonads of specimens collected near the major municipal sewage outfalls during 1971 and 1972 did not exceed the Federal limit of 5 ppm for DDT and PCB compounds in edible tissues (SCCWRP, 1974). But PCB levels in flesh of crabs living near the Hyperion 7-mile outfall were significantly higher than in crabs from other sections of the Bay. In general, however, Aroclor 1254 contamination of this crab is low but widespread in coastal waters. Gonadal tissues may contain concentrations of these synthetic organic compounds 5 to 20 times that of flesh.

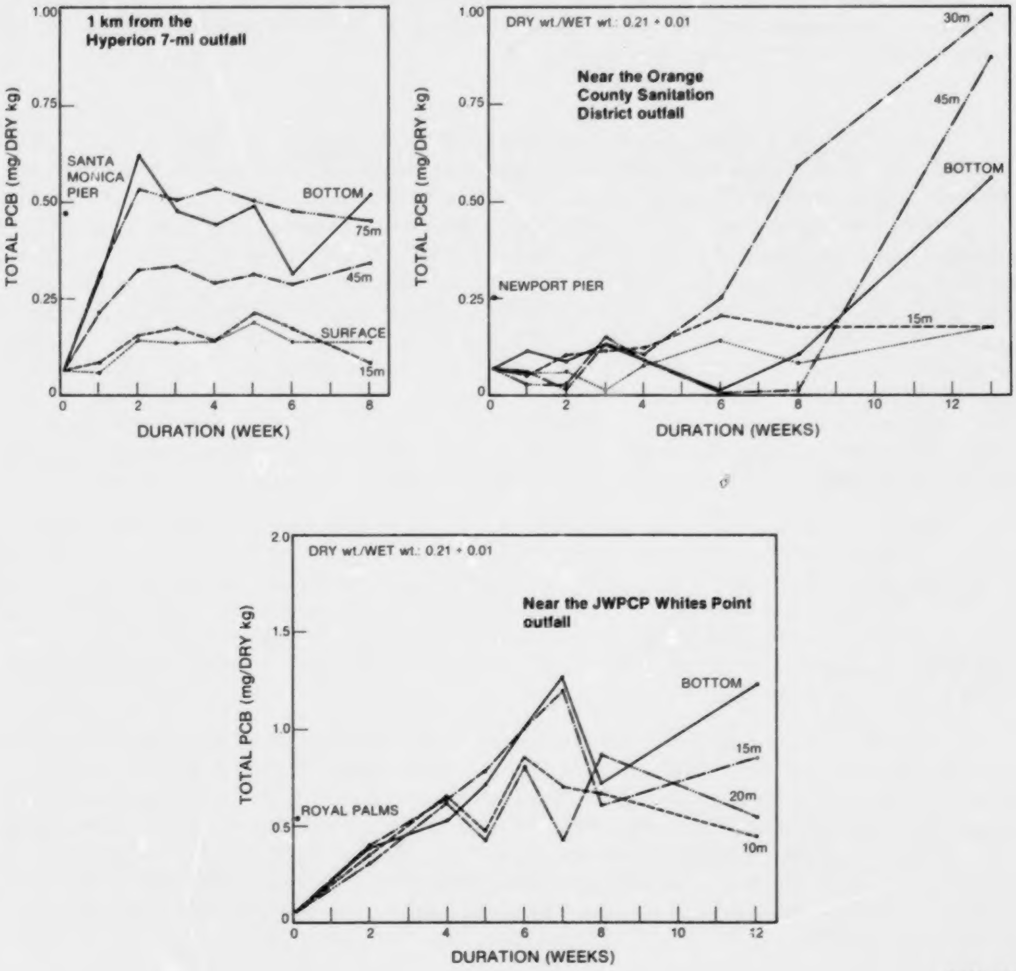

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Figure III-C-28. Tissue concentrations of PCB in previously uncontaminated mussels *(Mytilus californianus)* suspended at a range of depths near the 3 main southern California sewage outfalls (unpublished data from SCCWRP, provided by Young).

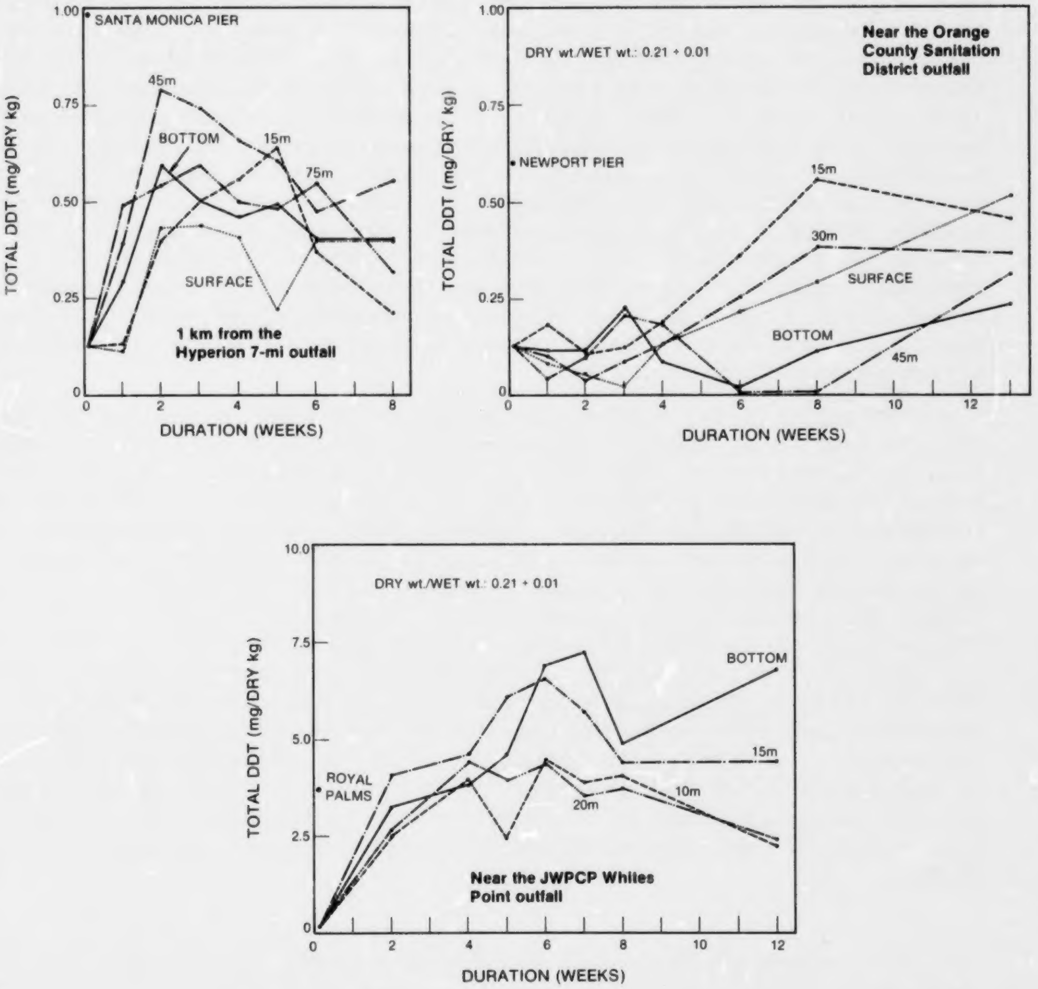

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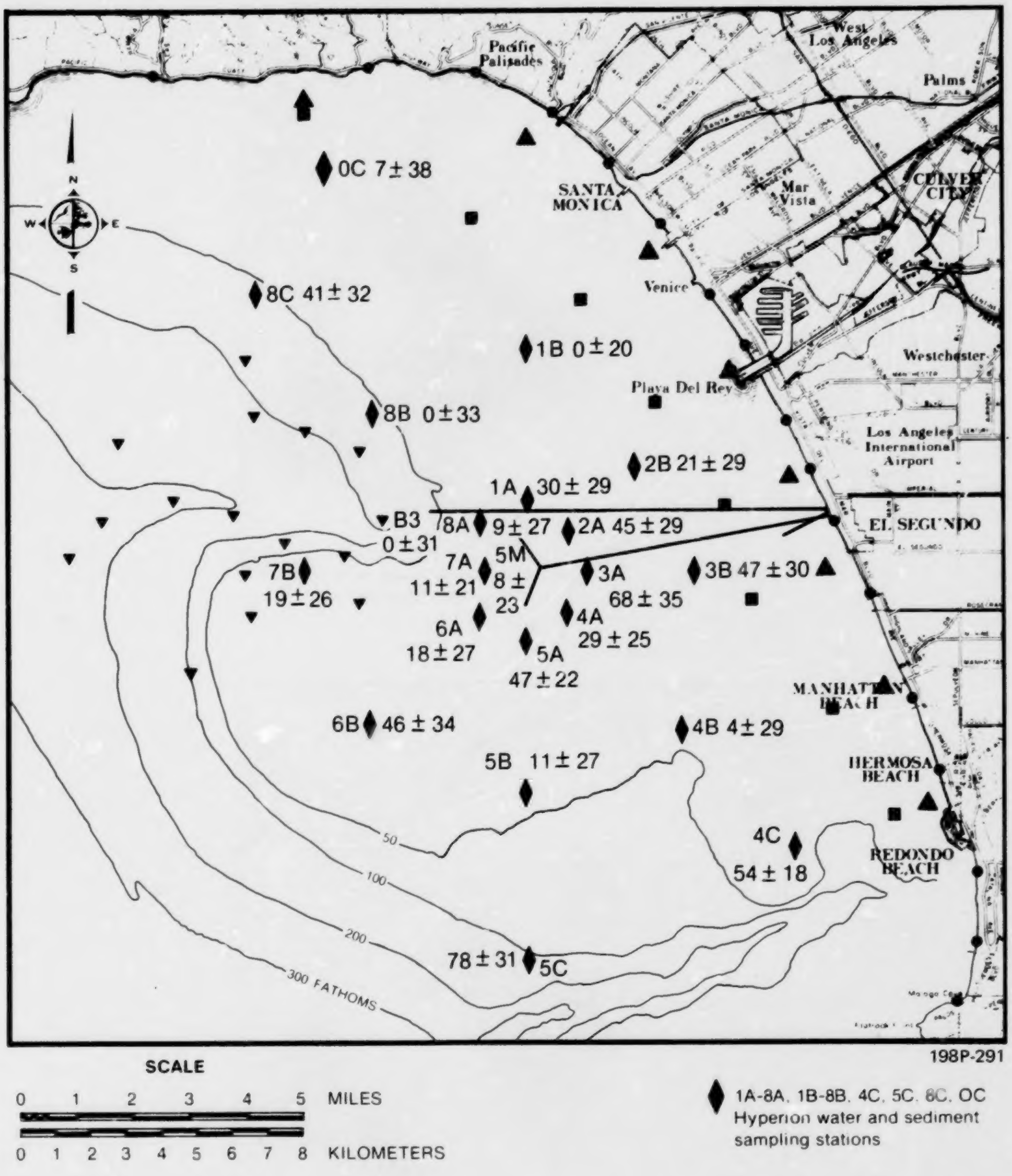
Figure III-C-29. Tissue concentrations of DDT in previously uncontaminated mussels *(Mytilus californianus)* suspended at a range of depths near the three main Southern Califronia sewage outfalls (unpublished data from SCCWRP, provided by Young).

(c) Uptake of Radioactive Isotopes by Marine Benthos. Little is known about the uptake of radioactive isotopes in benthic plants, although Hodge et al. (1974) found that giant brown algae rapidly accumulated plutonium and polonium on the surface of their blades. Radioactive isotopes discharged in sewage can be accumulated in benthic fauna by ingestion of contaminated food or by absorption directly from surrounding water or sediments. Triquet (1973) showed that the polychaete worm, *Arenicola marina,* concentrated cobalt-60 in their blood through ingestion of contaminated sediments. In a subsequent study, Amiard-Triquet and Amiard (1974) found assimilation rates of cobalt-60 by the crab, *Carcinus naenas,* to be high as a result of eating the polychaete, *A. marina*. Concentration of this isotope occurred in the hepatopancreas of the crab, and high concentration therein could result in very localized but relatively high internal exposure. Moreover, the exposures are long-term since cobalt seems to be retained in the body in a relatively unexchangeable form. The biological half-life of cobalt-60 in the polychaete, *A. marina,* is about 3 months (Amiard-Triquet, 1974).

Pentreath (1973) studied the uptake of zinc-65, manganese-54, cobalt-58, and iron-59 by the bay mussel and concluded that most is concentrated from isotopes in food organisms, rather than from water. The polychaetes, *Nereis diversicolor* and *Hermoine hystrix,* accumulated zinc-65 from the sediments in which they burrow (Renfro, 1975). *H. hystrix* required $\geq$ 60 days to reach a steady state with zinc-65 in the sediment. *N. diversicolor,* by burrowing through the sediment, caused losses of zinc-65 3 to 7 times higher than in sediments without worms. Moreover, a population of *N. diversicolor* could cause an annual loss of $\geq$ 3 percent of the zinc-65 in the upper 2 cm of sediment of a hypothetical radioactive benthic zone (Renfro, 1975). Radioassays conducted on coastal mussels, gooseneck barnacles, and benthic algae collected in the Southern California Bight revealed no bioaccumulation of various metal isotopes (SCCWRP, 1973). In Santa Monica Bay, radioactivity in the tissues of benthic organism (Figure III-C-30) shows little relationship to the HTP 5- and 7-mile outfalls, with the highest values being observed a great distance from either outfall.

(d) Uptake of Sewage-Derived Metals by Benthic Organisms Near HTP Outfalls. In 1973, Hyperion Treatment Plant published results showing concentrations of metals in the tissues (whole organism less shell) of organisms dredged from the ocean floor in the vicinity of the Hyperion outfalls. The least ambiguous of these data are shown in Figures III-C-31 and 32. Figure III-C-31 shows that the highest tissue concentrations of chromium and copper occur near the 5-mile outfall and not at the 7-mile outfall. Figure III-C-32 shows a much less localized tissue concentration of zinc, and a high concentration of tissue arsenic at a single point far removed from either outfall. These data suggest that organisms are not taking up metals from the sludge sediments, but in each case there is only a single sample in the vicinity of the 7-mile outfall sludge accumulation. Highest sediment metal concentrations, however, were observed in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Mar Vista
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Westchester
Playa Del Rey
Los Angeles International Airport
EL SEGUNDO
MANHATTAN BEACH
HERMOSA BEACH
REDONDO BEACH
N
S
E
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0C 7 ± 38
8C 41 ± 32
1B 0 ± 20
8B 0 ± 33
2B 21 ± 29
1A 30 ± 29
B3 0 ± 31
8A 9 ± 27
2A 45 ± 29
7A 11 ± 21
5M 8 ± 23
3A 68 ± 35
3B 47 ± 30
7B 19 ± 26
6A 18 ± 27
4A 29 ± 25
5A 47 ± 22
6B 46 ± 34
4B 4 ± 29
5B 11 ± 27
4C 54 ± 18
78 ± 31 5C
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198P-291
SCALE
0 1 2 3 4 5 MILES
0 1 2 3 4 5 6 7 8 KILOMETERS
1A-8A, 1B-8B, 4C, 5C, 8C, OC Hyperion water and sediment sampling stations

Figure III-C-30. Radioactivity (β-activity) in the tissues of benthic organisms collected in Santa Monica Bay in 1972. The standard errors are very large, and there is no obvious relationship of the values and the HTP outfalls (data from DPW, 1973).

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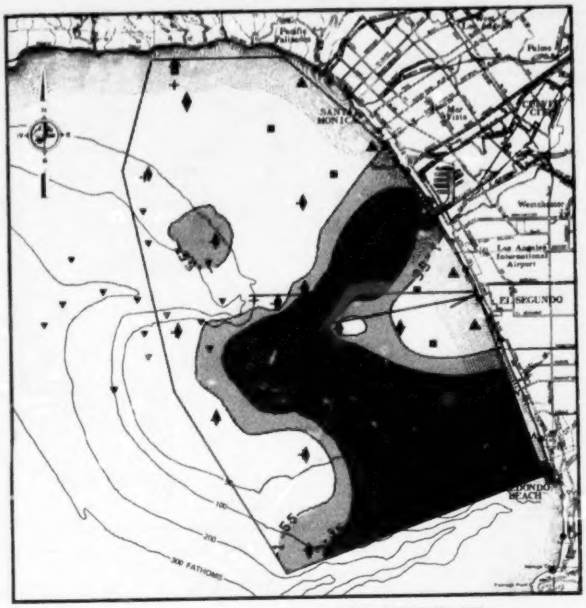
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TISSUE CHROMIUM

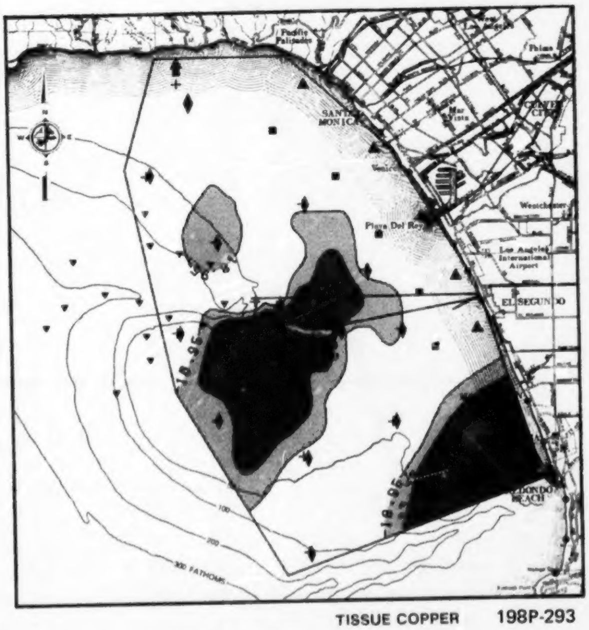
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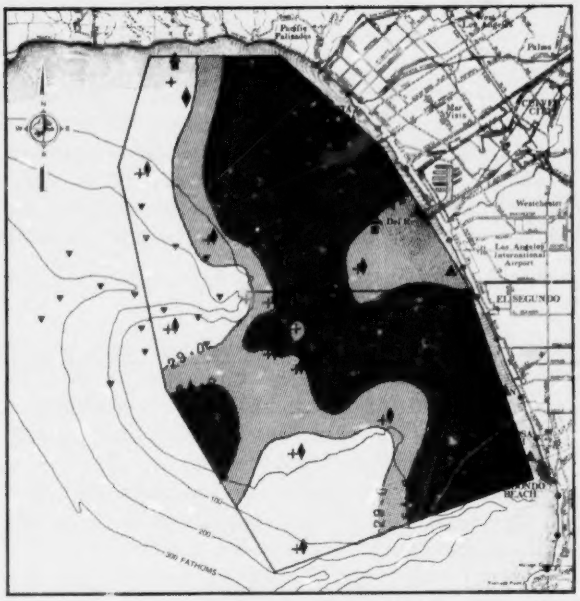
Figure III-C-31. Concentrations of chromium and copper in mg/dry kg in the tissues of benthic organisms collected near the HTP outfalls in 1972 (data from DPW, 1973).



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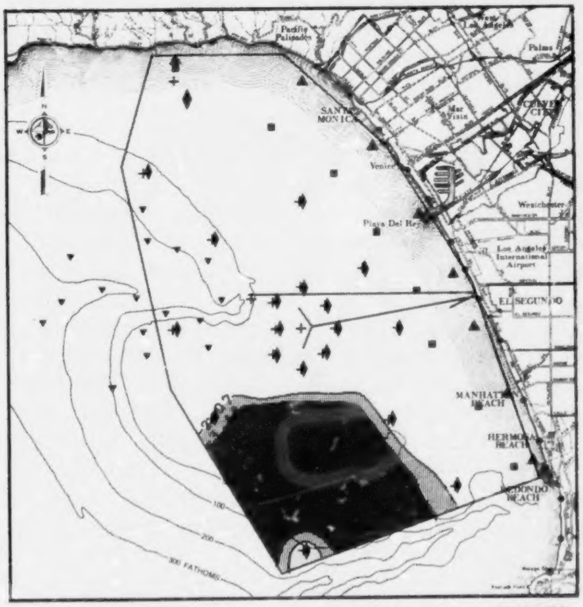
TISSUE ZINC



Pacific Palisades
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Playa Del Rey
Los Angeles International Airport
EL SEGUNDO
MANHATTAN BEACH
HERMOSA BEACH
REDONDO BEACH
100
200
300 FATHOMS

TISSUE ARSENIC 198P-292

Figure III-C-32. Concentrations of zinc and arsenic in mg/dry kg in the tissues of benthic organisms collected near the HTP outfalls in 1972 (data from DPW, 1973).

the immediate vicinity of 7-mile sludge outfall. Apparently much of the biological uptake of metals in Santa Monica Bay takes place from metals either dissolved or suspended in the water column, rather than deposited in the sediments. It should be noted, however, that the data supporting this last statement are minimal, and the analytical techniques utilized to determine tissue concentrations of metals were tentative and unperfected (DPW, 1973).

(e) Toxic Effects of Sewage Constituents From the HTP Outfalls on the Benthos. The biological effects of the discharged toxicants depend, of course, on the concentrations available in the water, sediments, or food organisms. Information on toxicity of various metals to benthic invertebrates as determined in the laboratory is fairly extensive. A summary of available information regarding metals and their biological effects is provided in Table III-C-2. Combinations of metals may act synergistically to increase their combined toxicity. For instance, Grey and Ventilla (1973) found that the sediment-living protozoan, *Christigera*, experienced a 67 percent growth reduction from simultaneous exposure to mercury, lead, and zinc, that in the same concentrations caused a total additive growth reduction of only 37 percent when each metal exposure was bioassayed separately. Similarly, the mud snail, *Nassarius obsoletus*, consumed less oxygen when exposed to both copper and cadmium, than when exposed to the metals separately, all other conditions being equal (MacInnes and Thurberg, 1973).

Lethal and sublethal effects of pesticides are also summarized in Table III-C-2. There is no information regarding the potential for synergistic enhancement of these compounds when discharged simultaneously. However, it has been shown that the sublethal effect of endosulfan upon the queen scallop, *Chlamus opercularis*, is enhanced with increased water temperature (Roberts, 1975). Table III-C-2 indicates mean concentrations in the effluent from the 5-mile and 7-mile outfalls and identify the constituents (by superscript) that are sufficiently concentrated in the undiluted effluent to have adverse effects on planktonic and benthic invertebrates. The 5-mile wastewater discharge, for example, releases cadmium, copper, silver, zinc, cyanide, DDT, and mercury in concentrations that may be detrimental, if undiluted, to certain listed marine organisms. The 7-mile sludge and wastewater discharge releases cyanide, silver, cadmium, chromium, copper, iron, mercury, lead, zinc, total DDT, and total PCB's in concentrations that may be detrimental.

(f) Diseases and Abnormalities of Benthic Invertebrates and Plants that May be Attributable to Sewage Discharges. Abnormal growths and severe fluctuation in population density have been reported in the giant kelp, *Macrocystis* spp., and the elk kelp, *Pelagophycus porra* (SCCWRP, 1973). These conditions, noted near the Point Loma and Palos Verdes outfalls, have been attributed to a complex assortment of causes, such as gradual warming of seawater increased predation by sea urchins and fish, wastewater discharges, and decreased light penetration resulting from sediment discharge. The kelp die-offs along Palos Verdes and Malibu (and the entire southern California coast) in the late 1950s were probably the result of warmer than usual water temperatures in 1957 to 1959. Indirect effects of increased grazing by predators and decreased water clarity also may have had some adverse influences on kelp in the immediate vicinity of outfalls such as the JWPCP outfalls at Whites Point. The observed regrowth along Palos Verdes in the last 2 to 3 years could be the result of numerous interrelated factors including improved wastewater discharge quality, natural growth cycles, and removal of predators (sea urchins). It is unlikely, however, that the present HTP outfalls (5 and 7 miles offshore) directly impact the remaining kelp in Santa Monica Bay.

In animals, "burn-spot diseases" consisting of exoskeletal lesions have been examined on the crabs, *Mursia gaudichaudii* and *Cancer* spp., collected off Palos Verdes, Santa Monica, and Newport Beaches. Lesions occurred in ≤ 70 percent of the crabs sampled at each location, and along the 405 foot contour, in Santa Monica Bay, 12 of 27 individuals collected were affected. Young crabs near the heads of submarine canyons had lesions while larger crabs with lesions were found more widely dispersed suggesting that crabs may spread the disease as they disperse. The lesions are contagious and, at times, are lost during molting (Sindermann and Rosenfield, 1967), but their exact cause has not been identified. Wastewater outfalls occur in the vicinity of the canyons where crabs with lesions were found which provides circumstantial evidence for a link between the disease and these discharges; however, no causal relationship has been demonstrated at this time.

Some of the sea urchins (*Strongylocentrotus purpuratus* and *S. franciscanus*) collected near Whites Point show spine loss, gonadal atrophy, and aberrations in the hemal axial gland and water vascular system (Johnson, 1971a & b). Johnson speculated that these conditions may result from starvation, but Moitoza (SCCWRP, 1973) suggested that they may also have resulted from the high levels of DDT found in nearby sediments. Equivalent evidence exists for both studies, so that it is not possible to ascertain the dominant cause of these abnormalities in sea urchins without further data.

e. Nektonic (Strongly Swimming) Invertebrates.

(1) DISTRIBUTION, ABUNDANCE, AND PRODUCTIVITY OF NEKTONIC INVERTEBRATES. Many of the larger planktonic invertebrates have swimming abilities that border on nektonic. Cephalopods, decapods, euphausids, mysids, and some other crustacean groups have species that may be classified as nektonic (BLM, 1975). The species of commercial or recreational value in southern California are ocean shrimp (*Pandalus jordani*), bay shrimps (*Crago* spp.), spot prawn (*Pandalus* spp.), pelagic red crabs (Galatheidae), and market squid (*Loligo opalescens*)(Frey, 1971). Appendix III.B lists some other pelagic cephalopods and the depths at which they were collected in the Southern California Bight.

The distribution of nektonic invertebrates varies both seasonally and diurnally. Most species school and many migrate vertically on a diel cycle. Some, especially mysids, are demersel or epibenthic part of the time and nektonic the remainder of the time, which is often at night. The red crabs occur in high concentrations near areas of upwelling in the California Current (Frey, 1971). Their distribution is controlled by variations in climatic factors and in flows of the California Current.

The market squid is most abundant in the spring when spawning takes place in near-shore areas. The abundance of nektonic decapod crustaceans is low in the Southern California Bight, not exceeding 49 organisms/1,000 m^3 (Atstatt and Seapy, 1974) for San Pedro and Santa Catalina Basins. *Sergestes similis,* the pelagic peneid shrimp, was the most numerous species in each sample.

The distribution and abundance of nektonic invertebrates in the vicinity of the Hyperion Treatment Plant outfalls have not been reported although visual and photographic surveys of the outfalls have been made. No nektonic invertebrates were included in the drawings made from still photographs along the Hyperion outfalls (see Figures III-C-10 through 14), and from these photographs it can be concluded that large readily identifiable nektonic invertebrates do not occur in high numbers near the outfalls. In videotapes taken by SCCWRP along the outfalls, however, there are great numbers of small rapidly moving objects (organisms) too small to be resolved by the television equipment used, whose movement is very suggestive of schools of shrimp-like crustaceans.

(2) THE EXISTING FISHERY FOR NEKTONIC INVERTEBRATES. Several nektonic invertebrates are collected commercially in the Southern California Bight. Squid (*Loligo opalescens*) is the most valuable in both weight landed and dollar value. The weights and values landed in the Los Angeles area for 1968 through 1972 are presented in Table III-C-12. Most are processed as wetfish, but some are sold as live bait. This fishery is moderately underutilized (BLM, 1975).

Table III-C-12. Commercial squid catch and value landed in Los Angeles Harbor from 1968 through 1972.

YEAR	CATCH (lbs)	VALUE ($)	REFERENCE
1968	7,693,532	117,389	Heimann and Carlisle, 1970
1969	6,182,983	124,206	Pinkas, 1970
1970	11,085,253	249,584	Bell, 1970
1971	8,185,108	150,605	Oliphant et al., 1973
1972	4,256,100	---	Bell, 1974

Ghost shrimp (*Callianassa californiensis* and *C. gigas*) and red shrimp (*Penaeus* sp.) are taken commercially for bait from bays in the Los Angeles area. In 1972, 7,122 kg (15,700 pounds) of ghost shrimp with a value of $35,700 and 499 kg (1,100 pounds) of red shrimp with a value of $1,100 were landed in Los Angeles (BLM, 1975). Although the monetary value of these organisms is low compared to that of edible shellfish, the weights landed were high considering the small size of the organisms.

Pelagic red crabs (family Galitheidae) were commercially taken in 1972 by trawl in the Santa Barbara area. At that time there was no described market use for these organisms (BLM, 1975).

(3) UPTAKE OF SEWAGE CONSTITUENTS BY NEKTONIC INVERTEBRATES. The uptake of toxic materials in nektonic invertebrates has received little attention in southern California. The uptake and concentration of chlorinated hydrocarbons and metals varies from species to species and is greatly influenced by the concentrations occurring in their food organisms.

Prawns (*Penaeus kerathurus*) from the Gulf of Cadiz, Spain, and along the coast of northwest Africa are reported to have 0.1 to 0.26 ppm of mercury in the tissue (Establier, 1972). Cesium-141 is accumulated by the euphausiid, *Meganyctiphanes norvegica,* mainly by surface adsorption (Fowler et al., 1973). The concentration factor is approximately 250, and 99 percent of the accumulation is lost with the first molt. When the isotope is ingested as labeled *Artemia,* 99 percent is voided in the feces.

(4) TOXIC EFFECTS OF SEWAGE CONSTITUENTS TO NEKTONIC INVERTEBRATES. No data are available describing the effects of trace constituents on the species of nektonic invertebrates found in the vicinity of the HTP outfalls; however, data on the lethal and sublethal effects of heavy metals and chlorinated hydrocarbons on shrimp from other locations are presented in Table III-C-2. The concentrations of all constituents in the present 5-mile effluent (undiluted) are below the lethal and sublethal levels for all organisms tested. The concentrations of copper and iron in the undiluted sludge, however, were within the lethal and sublethal ranges for the European brown shrimp, and DDT exceeded the lethal level for sand shrimp. There appear (on video tapes taken near the sludge outfall) large numbers of shrimp-like (but not yet identified) nektonic crustaceans. These may well be exposed to relatively undiluted liquid and particulate effluents. That they appear in great numbers suggests that the effluent provides some benefits perhaps in the form of particulate food; however, these benefits may be short-term compared to effects of the toxicants released.

f. Fish.

(1) DISTRIBUTION, ABUNDANCE, AND PRODUCTIVITY OF FISH. Of the 554 species of coastal marine fish known to occur along the California Coast, at least 481 species are found from Point Conception to the Mexican border

(Miller and Lea, 1972). The number of species and families increases from north to south along the California coast with 90 percent of the families occurring in southern California compared to 71 percent in northern California. A list of the families of fish found in southern California along with the number of species in each is presented in Appendix III.B.

The marine environment can be divided into two main regions, the deep basins and the shelf of the mainland and off-shore islands. Kelp beds, semi-enclosed bays, and man-made structures (oil rigs, harbors, breakwaters, etc.) are sub-divisions of the shelf habitat. The deep basins are inhabited mainly by pelagic (living in the open ocean) fish while the mainland and island shelf has primarily demersal (bottom-dwelling) species with a few pelagic species, such as anchovies. Many species are permanent residents while others are present only during some seasons.

Temperature, light, currents, food availability, and the presence or absence of predators are factors known to affect the distribution of fish. When upwelling occurs, many fish associated with coastal shelves avoid the intruding water mass by moving either in-shore (demersal fish) or to the the surface and off-shore (pelagic fish). They probably do so in response to differences in water characteristics such as temperature and dissolved oxygen. Some fish species such as those of the distinct San Diegan fauna are found only in association with the warmer waters that occur above the thermocline. Below the thermocline and in the deeper waters of the coastal shelf, the fish are cool water, temperate species with distribution centers north of the Southern California Bight (SCCWRP, 1973).

(a) Fish on the Coastal Shelf of the Mainland and Off-Shore Islands. The coastal shelf from Port Hueneme to Newport Beach and around Santa Catalina Island has been sampled for demersal fish in a trawling survey during 1969-1972 by SCCWRP (1973) and by several other investigators. Trawling, however, is selective for smaller and less mobile fish so that larger demersal as well as pelagic fish are seldom collected. In addition, trawls are ineffective in areas that are very shallow or rocky so that the species inhabiting such areas are not sampled. Even with these limitations, 121 species of fish representing 41 families were collected in the 303 samples taken on or near the bottom at depths ranging from 10 to 360 meters (Appendix III.B). Species of rockfish, sharks, rays, and flatfish were taken most often. The areas sampled were San Pedro Bay, Santa Monica Bay, Port Hueneme, off Palos Verdes, and off Santa Catalina Island. The 20 species captured most frequently (individuals occurring in most of the trawls) for all sites combined and the frequencies in Santa Monica and San Pedro Bays are indicated in Figure III-C-33. The principal species in each area sampled differ. Dover sole were found most often off Palos Verdes and in San Pedro Bay, hornyhead turbot were most frequent at Port Hueneme, speckled sanddab and plainfin midshipmen were most frequent in Santa Monica Bay, and Pacific sanddab was found most often around Santa Catalina Island. The total number of each that was caught along with the mean frequency of occurrence are shown in Figure III-C-34.

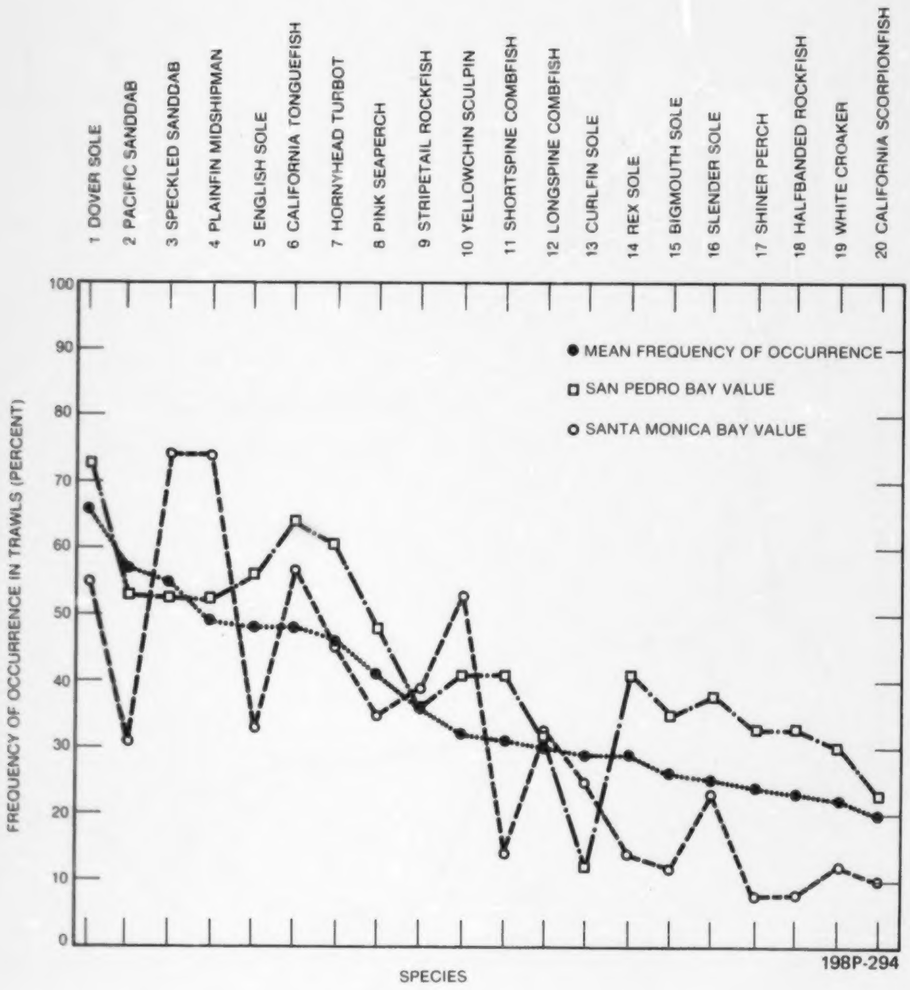


Figure III-C-33 Demersal fish taken in trawls in the Southern California Bight. Data from Santa Monica Bay and San Pedro Bay are shown separately, and it can be seen that they differ substantially from each other as well as from the mean values for Port Hueneme, Santa Monica Bay, Palos Verdes, San Pedro Bay, and Catalina Island. This result is expected because water depths and substrates differ in the two areas (data computed from SCCWRP, 1973).

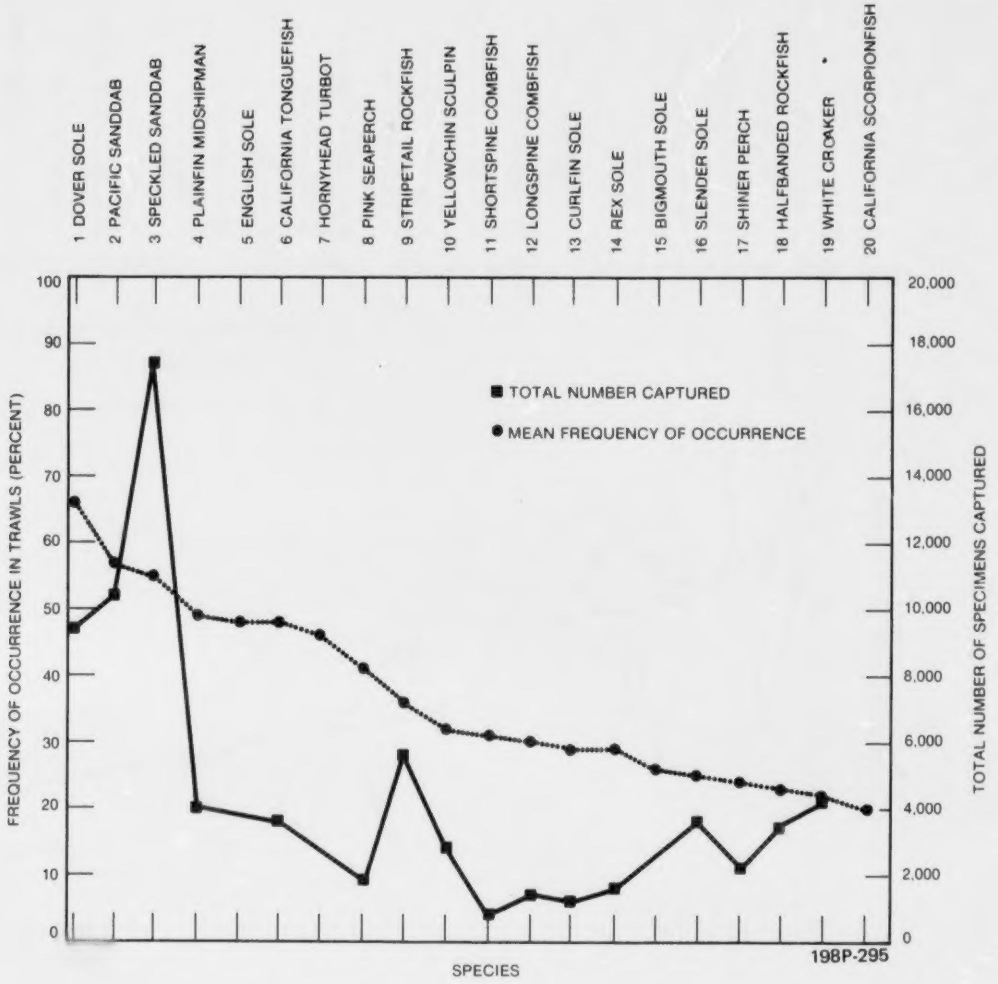


Figure III-C-34 Mean frequency of occurrence plotted together with the total numbers of fish captured in 1969-1972 trawls. This figure indicates that some species are widespread (occurring in a large percentage of the trawls but in small numbers when caught) while other species occur in aggregates (large numbers but in few trawls) (data compiled from SCCWRP, 1973).

Dover sole, Pacific sanddab, and speckled sanddab, in descending order of occurrence, were the three species most frequently collected in the Bight, and these were also the most abundant species, although in reverse order from frequency of collection. The differences in frequency of occurrence and abundance ranking for the individual species indicate that some of the species are not uniformly distributed within the sampled area. This is clearly shown by data on the white croaker which is fifth in abundance but nineteenth in frequency of occurrence (indicating high densities in some areas) while the English sole is fifth in frequency of occurrence but less than twentieth in abundance, refecting a wide but sparse distribution.

Sixty-one species of near-shore and intertidal fish have been observed near the San Onofre Nuclear Generating Station during 1963-1972 by diver surveys, intertidal observations, and traveling screen sampling (SCE, 1973). The species observed are indicated in Appendix III.B.

- Fish in Kelp Beds. Kelp beds are a specialized habitat found in shallow areas of the mainland and island shelf. Kelp serves as a food source and shelter for many organisms, including fish. It has not been shown to be a required habitat characteristic for most fish species, nor has it been shown to increase species diversity. Bottom topography appears to be a more important attractant than the kelp (North and Hubbs, 1968). Seventy three species of fish have been reported from kelp beds in southern California and northern Baja California using SCUBA (Appendix III.B). The mean standing crop of resident species was 0.35 g/m^2 (313 pounds /acre) (North and Hubbs, 1968). Kelp bass, California sheephead, and blacksmith were the most frequently encountered species in kelp beds near San Diego while kelp bass, topsmelt, and kelp perch were the most frequent off Gaviota (near Point Conception).

- Fish in Harbors. The fish of two man-made harbors in southern California, King Harbor at Redondo Beach and the Los Angeles-Long Beach Harbor, have been studied in some detail. One hundred and twenty six species of fish from 48 families were reported for King Harbor. Abundance of fish was greater in the summer than in winter, and the standing crop was estimated to be 13.0 to 19.5 g/m^2 (BLM, 1975). The annual productivity was estimated at 56 percent of the standing crop. The Los Angeles-Long Beach Harbor has a variety of habitats including sand/mud bottom, rocky bottom, rock and concrete breakwaters, wood and concrete pilings, sandy beaches, estuaries, and small islands. A density of 8.9 $fish/m^2$ was found from trawls taken during 1972-1973. The species diversity was 1.29 which approximates that found at similar depths outside the harbor (Stephens et al., 1974). Three areas of fish distribution have been observed: one of high flatfish abundance, one of croaker abundance, and one of rockfish abundance (BLM, 1975). The area of croaker abundance seems to correspond to that of nutrient enrichment (sewage) and possible low dissolved oxygen. Surveys using trawls, seines, gill nets, hook-and-line, and diving recorded 126 species in the Harbor (Appendix III.B) (Dames and Moore, 1973;

Chamberlain, 1974). The abundance of fish varied seasonally with fewer present in the winter than summer, and the annual productivity was estimated at 7.3 to 16.5 g/m^2 (Stephens et al., 1974).

- Fish Near Man-Made Habitats (Excluding Sewage Outfalls). Other man-made habitats that have been studied are off-shore oil drilling installations and reefs composed of deliberately placed car bodies, a streetcar, quarry rock, and concrete shelters. Eighty six species of fish have been observed around these structures. All of the structures appear to attract fish with populations growing from a few fish to several thousand semi-residents (BLM, 1975). The in-shore structures typically attracted kelp fish (Clinidae), croakers (Sciaenidae), and small sharks. The deeper water towers attracted schooling pelagic fish as well as some species of rockfish not associated with the in-shore areas. The dominant fish in both areas were surfperches (Embiotocidae). The fish population increased rapidly in the first year and then fluctuated, apparently because of natural factors (BLM, 1975). Surfperches and serranid basses were dominant during the first two years of reef life only to decrease as the usual reef residents such as cottids, gobies, damselfish, and others increased in abundance. A species composition characteristic of natural reefs was reached in approximately five years (Turner et al., 1969).

- Fish in Embayments. Nineteen major embayments occur along the coast of southern California; however, only three of these have remained relatively unaltered by man (Anaheim Bay, Upper Newport Bay, and Tijuana Estuary). Fish have been studied in Anaheim and Newport Bays, and the species present are generally recruited from the ocean. Of the 68 species found in Anaheim Bay, at least five of the most abundant species are known to be permanent residents: topsmelt, California killfish, arrow goby, diamond turbot, and shiner perch (BLM, 1975). Anaheim Bay is used as a spawning area by the deep-body anchovy and the gray smoothhound, and as a nursery area by the California halibut and the Pacific staghorn sculpin.

- Fish Near the Hyperion Treatment Plant Outfalls. Sampling of fish in Santa Monica Bay to study the effects from the Hyperion outfalls has been conducted from 1958 through 1975. Quarterly otter trawls were taken by the Los Angeles City Bureau of Sanitation and the California Department of Fish and Game during 1958 through 1963, and the data were reanalyzed by Mearns et al. (unpublished). Carlisle (1969) suggested that the speckled sanddab was attracted to the vicinity of the 7-mile discharge, and at least three species (speckled sanddab, yellowchin sculpin, and California tonguefish) tend to avoid the area surrounding the 5-mile discharge. The reevaluation of the data collected at 60 m near the 5-mile outfall and at 100 m near the sludge outfall showed a reduction in the mean number of species and median number of fish per trawl relative to sampling stations at the same depth up the coast (Mearns et al., unpublished). This reduction may be a natural phenomenon or related to wastewater discharge. Data collected at 180 m in depth from stations near the sludge field in Santa Monica Canyon showed a tendency toward a depression in the number of species present with a possible increase in abundance.

A limited amount of trawling was conducted in Santa Monica Bay during 1971 by Hyperion with the aid of Orange County and Los Angeles County personnel in February and June and SCCWRP in September. One survey was conducted for each sampling period (Allen, 27 May 1976), and the data were not analyzed. In 1972 three studies were conducted in Santa Monica Bay. In May and June, HTP and SCCWRP jointly trawled at 34 stations from Redondo Canyon on the south to off Malibu on the north at depths of 18 to 200 m (Mearns et al., 1974). The most abundant species were speckled sanddab and yellowchin sculpin. Diversity increased with depth, and the number of fish and number of species per trawl was highest at depths of 36 to 61 m.

Hyperion conducted two trawls each near the 5-mile outfall (60 m depth) and at a control station to the northwest at the same depth on 1 November 1972. At the outfall station 276 fish in 12 species were collected with speckled sanddab and yellowchin sculpin the most abundant. At the control station 139 fish in 10 species were collected with yellowchin sculpin, stripetail rockfish, California tonguefish, and plainfin midshipman the most abundant.

In April of 1973, Hyperion and SCCWRP conducted a trawl survey using the same grid as the 23 May - 2 June 1972 survey. The data from this study have not been analyzed.

In June and July of 1974 seven regions in three major depth zones along the 5-mile and 7-mile effluent pipes were photographed to identify the organisms residing on or near the pipes (Allen et al., 1976). The shallow zone of 10 to 30 m was photographed by Harry Pecorelli using SCUBA while the deeper zones, 40 to 50 m and 60 to 100 m, were photographed from a two-man submarine. The regions sampled and the most frequently observed organisms are shown in Figures III-C-10 through 14. At least 30 species of fish were observed in the photographs. The species found and the sampling region in which each occurred is presented in Table III-C-7.

Water-column fish were more abundant and larger at the deeper sampling regions than in shallow water near both pipes. Over half the species observed were rockfish, and these were by far the most frequently noted fish species (Allen et al., 1976). The schools and aggregations of fish may be using the pipes as a location reference point, and in addition may feed upon the invertebrates as well as fish found on or near the pipes. Fish also use the crevices formed by the rock ballast and anchors in shallow water.

A hook-and-line survey was conducted by SCCWRP from 27 March to 9 May 1975 at 12 stations (18 to 180 m in depth) near and to the northwest of the Hyperion 7-mile sludge pipe (Allen et al., 1975). The study was designed to determine if hook-and-line sampling would provide data different from that obtained by otter trawling in terms of species composition, abundance, size, and frequency of disease in demersal fish. Setlines containing 100 hooks were set along the bottom at each station and rod-and-reel fishing was conducted in fish schools located by sonar. The sampling did not collect any species that had not already been taken by otter trawl, but the dominant species collected by the two methods were quite different. Rockfish and flatfish were dominant in trawls while rockfish, white croaker, sablefish, and spiny dogfish were dominant in the hook-and-line survey. The greatest biomass and number of species per station were collected near the end of the sludge outfall, and the abundance was generally greatest along the shelf (60 to 100 m depth) near the sludge outfall. Three of the four diseased fish collected were from near the sludge outfall.

Recurrent group analysis of the hook-and-line catch data showed two species associations not found by the otter trawling (Allen et al., 1975). In shallow water the white croaker and spiny dogfish were associated, and in deeper water the sablefish and bocaccio (rockfish) were associated. These associations are not evident in the trawl data since spiny dogfish and sablefish are probably not well sampled by trawling.

(b) Fish in Deep Basins. The deep basins have a distinctive fish fauna containing species from three converging water masses as well as species endemic to the California Current system (BLM, 1975). All of the basins have mesopelagic fish (150 to 1,000 meter depth interval) while only the deeper basins have bathypelagic fish (usually deeper than 800 to 1,000 meter). Many of the mesopelagic fish migrate to near the surface during the night returning to deeper water during the day. For the Southern California Bight, 93 species of fish representing 30 families have been reported (BLM, 1975). The most frequently collected species were a mesopelagic bathylagid, *Leuroglossus stilbius,* and two mesopelagic myctophids, *Stenobrachius leucopsarus* and *Triphoturus mexicanus*. The larvae from three families (Bathylagidae, Gonostomatidae, and Myctophidae) are relatively abundant with 4 species collected (Ahlstrom, 1959, 1965, and 1969). These larvae occur in the upper mixed layer and in the upper part of the thermocline between the surface and 125 meters in depth.

(2) THE EXISTING COMMERCIAL AND RECREATIONAL FISHERY. Most of the commercial and recreational species landed are pelagic fish or near-shore predatory species such as halibut and rockfish. The coastal marine fish fauna of southern California has changed considerably in the past 30 years. Many of the previously abundant sport and commercial species have almost disappeared (sardines, Pacific mackerel, giant sea bass), and the remaining major fish stock is restricted to the seasonally migrating tunas (BLM, 1975). The changes in the abundance of commercial and sport species may be attributable to fishing pressure, although pollution and habitat destruction have undoubtedly had some effect.

(a) The Commercial Fishery in the Bight. The principal commercial fishing grounds are the mainland coast waters, around the Channel Islands, and the Cortes and Tanner Banks. The area off San Pedro Bay receives the greatest fishing pressure. Commercial fishing is mainly by purse seine and hook-and-line. Trawling for demersal species accounts for only a small proportion of the total catch, except in the Santa Barbara area (BLM, 1975). Figure III-C-35 shows the number of fish and shellfish landed for Santa Barbara, Los Angeles, and San Diego during the period 1943 through 1971. The large decrease in the early 1950's reflects the decline in the sardine fishery which probably resulted from reproductive failure as well as over-fishing. Commercial fish landings and shipments into California have generally decreased over the last 20 years (Figure III-C-36). The wetfish industry (sardine, anchovy, mackerels, and squid) is only one-sixth as productive as in 1936 and has changed because of the decline of the sardine catch during 1945 to 1950 with the subsequent increase in the anchovy catch. Anchovy, however, are not canned as were sardines but are processed into fish meal and oil (BLM, 1975).

In 1972 approximately 94 percent of the tuna catch was made outside California waters and then brought into California for processing. As of 1974 there were 13 canning and reduction plants and 17 curing and manufacturing plants in southern California (BLM, 1975). Three-quarters of the canning and reduction plants and over half of the curing and manufacturing plants are located in the Los Angeles area.

Live baitfish landings for sale to sport fishermen are reported for all of California in Table III-C-13 for 1968-1972. Anchovies were caught in far greater abundance than any other species.

The southern California landings in pounds and the dollar value of the fin fish catch, excluding yellowfin and skipjack tunas, for 1971 and 1972 are shown in Table III-C-14. These tunas are omitted since they are collected out-of-state. Table III-C-15 lists the weight and dollar value of the 1971 (the most recent year for which data are available) landings for each species of fish and shellfish in the three major southern California regions. Yellowfin and skipjack tuna accounted for approximately 250 million pounds and $50 million of the total landings which represents 53 and 76 percent of the total weight and volume. These dollar values are the money received by the fishermen and do not include processing and marketing which would increase the value of the fishery considerably.

The net economic value of sport fishing off the California coast in 1970 was estimated to be of value comparable to, or greater than the value of commercial fishing by Gruen, Gruen, and Associates (1972) cited in BLM (1975). The assumptions used were that tuna caught in out-of-state waters be excluded from the commercial catch, and that the gross landed value of $30 million worth of other marine species be reduced by half for a net economic value of the commercial fishery in 1970 of $15 million. The marine sport fishery was estimated at 12 million angler days, and values of $2, $3, and $4 were multiplied times the angler days to estimate sport value. Although the value that should be assigned to a sport fishing angler-day is by no means obvious, if there are 12 million angler days a year, marine angling certainly is a major source of recreation.

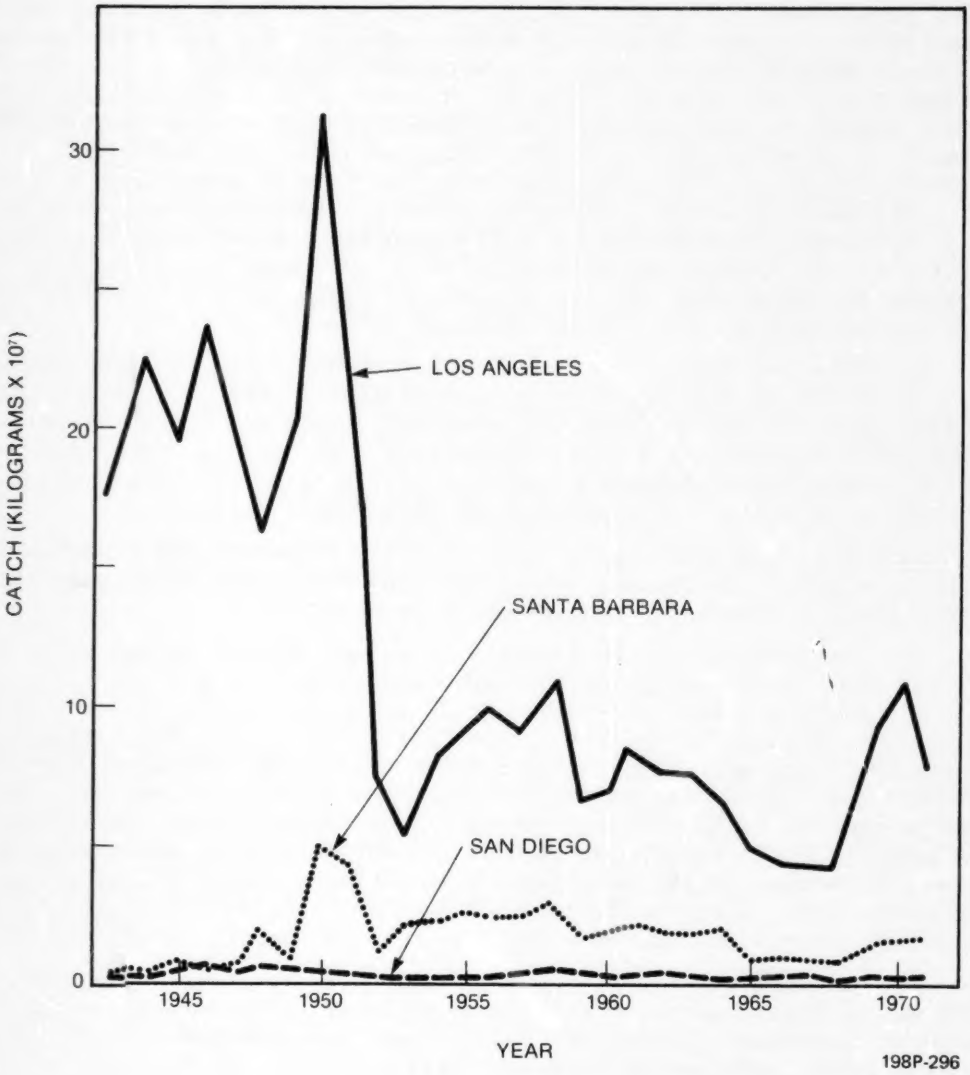


Figure III-C-35. Commercial fish and shellfish landings by wet weight in southern California for the period 1943 through 1971 (adapted from SCCWRP, 1973).

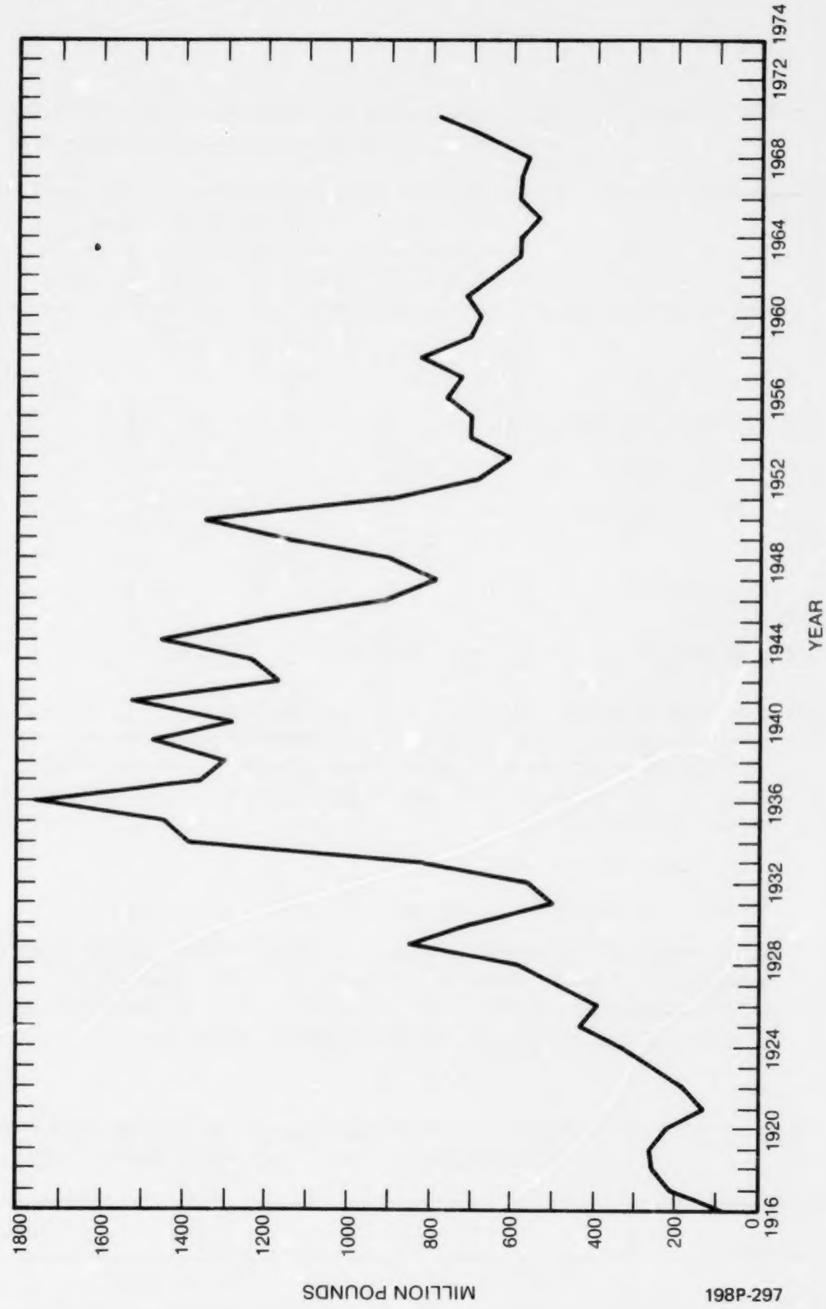


Figure III-C-36. Total annual commercial landings and shipments into California, including molluscs and crustaceans. Sardine deliveries to reduction ships (1930 to 1938) are also included. Since 1965 tunas are the only species included in shipments (redrawn from Bell, 1971).

Table III-C-13. Recorded catch of live bait in California for saltwater sportfishing during 1968-1972 (BLM, 1975).

SPECIES	THOUSANDS OF POUNDS[1]				
	1968	1969	1970	1971	1972
Anchovy	14,353	10,627	12,210	12,774	11,700
Mackerel, jack	158	103	--	9	5
Mackerel, Pacific	--	8	--	1	--
Sardine, adult	57	34	--	--	T[2]
Sardine, juvenile	--	--	6	T[2]	T[2]
Squid	23	9	--	10	--
Miscellaneous[3]	57	--	4	--	16
Total Pounds	14,648	10,781	12,220	12,794	11,721
Number of Vessels[4]	19	10	11	14	12

[1] Weights are estimated from voluntary records and should be regarded as minimal because some fishermen do not supply catch information.

[2] Less than 500 pounds.

[3] Consists primarily of queenfish and white croaker.

[4] The number of live bait fishing vessels for which landings were reported. These numbers differ slightly from those in previous catch bulletins, since the earlier landing records, as submitted, sometimes included the catch of more than one boat.

Table III-C-14. Total commercial fin fish landings for southern California in 1971 and 1972 (BLM, 1975).

AREA	POUNDS LANDED		VALUE	
	1971	1972	1971	1972
Santa Barbara	31,434,214	36,604,228	$ 768,491	$ 935,379
Los Angeles	171,512,733	205,033,211	9,938,853	10,807,459
San Diego	16,303,752	16,322,538	3,768,594	3,840,875
TOTAL	219,250,699	257,959,977	$14,475,938	$15,583,713

Table III-C-15. Weight and dollar value of the commercial landings of fish and shellfish in the three main southern California regions for 1971 (BLM, 1975).

SPECIES	SANTA BARBARA		LOS ANGELES		SAN DIEGO	
	WEIGHT (lbs)	VALUE ($)	WEIGHT (lbs)	VALUE ($)	WEIGHT (lbs)	VALUE ($)
Yellowfin tuna	--	--	122,445,911	25,517,727	28,495,200	5,924,152
Skipjack tuna	--	--	78,015,296	14,339,212	23,362,342	4,289,326
Anchovy	19,721,639	268,214	67,255,374	759,986	327	54
Jack Mackerel	2,295,898	91,836	57,411,853	2,313,697	10,307	544
Pacific bonito	599,800	47,323	17,111,661	1,558,873	2,515,189	232,152
Bluefin tuna	--	--	10,399,116	2,263,945	6,371,850	1,274,370
Squid	6,683,735	96,914	8,185,108	150,605	1,945	200
Albacore	3,700	1,495	6,403,280	2,018,314	5,898,994	1,849,925
Bigeye tuna	--	--	1,586,784	332,904	219,254	45,714
Abalone	1,097,570	396,611	887,464	247,503	631,425	185,250
Rockfish	823,600	65,508	451,216	92,709	377,531	80,328
White seabass	120,200	46,186	421,451	163,987	233,264	99,977
Rock crab	129,422	11,713	360,296	51,522	20,319	2,869
California yellowtail	--	--	332,794	37,673	57,690	7,160
White croaker	--	--	227,028	16,371	3,203	386
Pacific pompano	--	--	175,798	40,679	13	3
Sardine	--	--	163,686	35,160	134,200	33,550
Flyingfish	--	--	160,266	23,976	--	--
Pacific mackerel	--	--	153,531	7,230	2,245	328
Shark	37,750	4,831	120,939	16,980	199,895	37,982
Smelt	--	--	107,817	5,785	8	1
Giant seabass	--	--	104,393	23,947	11,983	3,190
California halibut	66,500	36,876	78,863	30,599	12,263	5,691
Spiny lobster	75,323	102,839	73,553	103,445	72,570	98,245
Swordfish	25,100	13,843	53,542	27,033	72,627	43,853
Blacksmith	--	--	42,340	965	--	--
Petrale sole	204,200	33,934	16,235	2,760	--	--
Perch	--	--	14,999	3,028	10,811	2,249
Halfmoon	--	--	10,526	2,623	12,596	2,947
California barracuda	--	--	8,998	3,015	7,894	2,454
Carp	--	--	6,766	970	--	--
California sheephead	--	--	6,070	667	2,374	352
Opaleye	--	--	3,217	672	2,064	282
Lingcod	66,175	3,596	3,157	362	505	59
English sole	297,200	28,700	2,380	286	--	--
Sculpin	--	--	1,886	693	129,258	41,402
Ocean whitefish	--	--	1,072	102	2,611	319
Sablefish	--	--	731	92	460	46
Dolphinfish	--	--	730	126	109	27
Sanddab	--	--	468	99	171	46
Sargo	--	--	287	66	147	15
Miscellaneous sole	--	--	184	24	1,215	343
Miscellaneous fish	--	--	133	35	335	98
Flounder	--	--	8	2	46	12
Miscellaneous animal food	359,500	7,191	--	--	--	--
Salmon	4,778	3,534	--	--	--	--
Rex sole	36,027	4,122	--	--	--	--
Sand Sole	29,866	4,178	--	--	--	--
Turbot	18,500	--	--	--	--	--
Cabezon	--	--	--	--	32	4
Miscellaneous crustaceans	--	--	--	--	30	12
TOTAL	32,696,483	1,269,444	373,287,437	50,196,438	68,875,134	14,265,923
Total excluding skipjack and yellowfin tuna	--	--	172,826,230	10,339,499	17,017,529	4,052,445

(b) The Recreational Fishery in the Bight. Sport hook-and-line fishing is very intense along the coasts of Los Angeles, Orange, and San Diego Counties and off Santa Catalina and Santa Cruz Islands. Sport fishing, by definition, includes party boat, private boat, shoreline, and pier and jetty fishing. Skin and SCUBA diving have also developed into a substantial fishing pressure in recent years. The following discussion is limited since only party boat catch records area available for both fishermen and divers.

Party boat fishing is concentrated along the mainland coast and around the off-shore islands. The largest catches in 1971 and 1972 were from the western end of the Palos Verdes Peninsula, the eastern edge of Santa Catalina Island, and northern San Diego (BLM, 1975). The catch consisted of 9.0 to 57.2 percent rockfish for the period 1955-1971 with kelp and sand bass, Pacific bonito, and barracuda contributing substantial numbers. The 1972 catches for the coast from San Diego to Santa Barbara are shown in Table III-C-16. Rockfish are becoming the predominant species caught, representing 48 percent of the 1972 catch.

Table III-C-16. Number of fish caught by the southern California recreational partyboat fleet in 1972 by port[1] (BLM, 1975).

SPECIES	SAN DIEGO MISSION BAY	DANA HARBOR OCEANSIDE	HUNTINGTON BEACH NEWPORT BALBOA	SAN PEDRO LONG BEACH	MALIBU REDONDO BEACH SANTA MONICA	SANTA BARBARA PORT HUENEME	TOTAL SOUTHERN CALIFORNIA
Rockfish	148,029	51,037	118,602	321,284	726,580	568,951	1,934,483
Kelp & Sand Bass	100,140	125,698	121,743	255,106	116,854	123,140	842,681
Pacific bonito	90,385	83,616	71,712	87,246	79,122	6,525	418,606
Pacific mackerel	114,803	49,762	44,773	27,189	8,700	614	245,841
Halfmoon	8,748	1,149	12,994	62,896	40,118	33,732	159,637
Salmon	12	8	6	7	12	57	102
Lingcod	4,073	131	128	277	157	7,809	12,575
Albacore	75,544	550	100	31	---	125	76,350
Sculpin	6,566	13,237	16,908	19,610	7,635	1,921	65,877
Yellowtail	52,976	724	189	2,036	2,382	724	59,031
White croaker	68	21,883	12,999	1,792	30	250	37,022
Barracuda	24,473	4,311	941	4,549	3,420	549	38,243
Sheephead	6,778	2,738	3,209	8,527	1,805	10,482	33,539
Ocean whitefish	5,602	1,209	1,823	6,109	1,879	7,993	24,615
Misc. flatfish	1,221	536	166	1,929	2,167	3,656	9,675
Sablefish	10	98	1,080	662	9,160	497	11,507
Cabezon	421	317	437	258	374	1,722	3,529
Calif. halibut	1,604	2,066	571	1,307	944	1,360	7,852
Jack mackerel	2,186	48	483	403	625	88	3,833
Croaker	15	3,957	2	1	---	21	3,996
White seabass	1,849	252	323	874	333	205	3,836
Bluefin tuna	1,436	17	3	1	---	1	1,458
All others	19,825	3,721	5,262	2,202	1,761	1,107	33,878
Total Fish	666,764	367,065	414,454	804,296	1,004,058	771,529	4,028,166
Total Anglers	166,000	64,227	50,913	92,366	111,115	68,052	552,673
Total Boats	100	16	24	59	13	35	247

[1] Smaller ports not listed separately are included in neighboring areas.

Note: The catch by boats from the Santa Monica Bay area accounted for one quarter of the total catch in the Bight.

Private boat catches were similar to those of the party boats during 1963-1966. Shoreline fishing was dominated by surf perch while pier and jetty fishing yielded mainly white croaker and queenfish (Pinkas et al., 1968). A comparison of the four types of fishing shows that party boats account for 57 percent of the sport fishing catch, pier and jetty fishing 26 percent, private boats 14 percent, and shoreline angling 3 percent (Pinkas et al., 1968). The estimated expenditures by sport fishermen in 1970 are presented in Table III-C-17 for the five southern California counties. The highest expenditures were in Los Angeles and Orange counties which also had the most angler days. An increase of approximately 25 percent in the number of angler days is projected for the period 1970 to 1980.

Skin and SCUBA diving have increased rapidly since the mid 1950's. Logs from California charter boats reported that 83,996 divers landed 199,466 fish, molluscs, and crustaceans during the period 1965 to 1970 for an average of 2.4 animals per diver. Most of the catch was composed of molluscs and crustaceans. Eight to nine percent of the catch were sheephead and four to six percent were kelp bass (Young, 1973). Data for private boat and shoreline divers are not available.

Table III-C-17. Annual number of angler days and estimated expenditures of sport fishermen in the five coastal counties of southern California (California Department of Fish and Game Planning Team, 1973 in BLM, 1975).

COUNTY	ANGLER DAYS (ANNUAL AVERAGE)		ESTIMATED EXPENDITURES 1970
	1970	1980 (PROJECTION)	
Santa Barbara	187,500	236,300	$ 2,294,000
Ventura	662,500	834,800	8,104,000
Los Angeles	2,875,000	3,622,500	35,166,000
Orange	2,700,000	3,400,000	32,800,000
San Diego	1,200,000	1,500,000	14,700,000
TOTAL	7,625,000	9,593,600	$93,064,000

NOTE: This table shows that over half the sport fishermen in the Bight are from the Los Angeles area, and that by 1980 sport fishing is expected to increase approximately 25 percent over that in 1970.

(c) The Existing Fishery in Santa Monica Bay. Santa Monica Bay is closed to commercial fishing except for fishing with small nets for sportfish bait. The landings of fish and shellfish are minor compared to other ports in the Bight (BLM, 1975).

Sport fishing in the Bay is fairly intense. The coastline from Point Dume to the Palos Verdes peninsula is mostly sandy beach, and over half is publicly owned. There are eight piers and two jetty fishing areas. The most common species taken by the pier and jetty anglers are queenfish, white croaker, Pacific bonito, surf perch, California barracuda, topsmelt, and jacksmelt (BLM, 1975). Party boats operate out of four areas, and boat rental and launching facilities are available. Shoreline fishing and SCUBA diving are also prevalent.

(d) The Existing Fishery in San Pedro Bay. The commercial fishery in San Pedro Bay is limited to bait fish and shellfish while the area outside the Bay is heavily exploited for commercial species, and many fish are brought into the harbor for processing. In 1972 Los Angeles Harbor led the United States in value and weight of fish landed (including out-of-state tuna catches). Processing facilities include canneries (mainly for tuna), fresh fish landings, reduction plants for fish meal and oil (anchovies), and curing and manufacturing facilities for the production of fish products (BLM, 1975).

Sport fishing is similar to that in Santa Monica Bay. Party boats operate out of the ports of Long Beach and San Pedro, and small boat rentals are available. Jetty fishing is done from the outer harbor jetties, and the species caught are similar to those taken in Santa Monica Bay (BLM, 1975).

(e) Influence of Nutrients from the HTP Effluent on the Fishery. The effluent from HTP contains nutrients (inorganic nitrogen in the form of ammonia, nitrates,and nitrites and inorganic phosphate) which are required and used by phytoplankton. Thus, if these substances are introduced into the euphotic zone where phytoplankton live, the growth and productivity of phytoplankton will be enhanced up to the point that other substances, either in the effluent or occurring naturally in the sea water, become limiting (Dunstan, 1975). Phytoplankton (and other marine plants), because of their ability to utilize the energy in sunlight to construct large organic molecules, produce most of the naturally occurring food in the sea. They therefore, constitute the food base which is the source of energy for other marine life including commercially and recreationally harvested species. Any inputs into the ocean which enhance their productivity potentially enhance the fishery.

The effluent from HTP also contains organic compounds. These compounds are primarily made up of carbon and hydrogen (hydrocarbons) and some contain nitrogen. The vast majority of the organic compounds released by HTP are essentially non-toxic and may be utilized as food by marine organisms. They consist of the partially degraded bodies of microorganisms utilized in the sewage treatment process and the partially degraded organic materials introduced into the sewer system (including household garbage and human excretions). These substances can be utlilized directly as food by zooplankton and filter-feeding invertebrates in the sea, and in this way constitute a food base separate from that of the phytoplankton. To the extent that the energy and elements from them pass into harvested organisms, they too enhance the fishery.

Some of the organic compounds containing nitrogen, particularly amino acids which when linked together form proteins, are absorbed or ingested directly by marine organisms other than phytoplankton and form a nitrogen source to the marine food web separate from the inorganic nitrogen captured by phytoplankton. Other organic nitrogenous compounds, urea for example, can be oxidized in sea water with or without the help of microorganisms to release their nitrogen and make it available to phytoplankton.

It must be noted, however, that substances which are either directly toxic to or bioaccumulated to toxic levels in marine organisms are also discharged along with the nutrients. The influence of these toxicants on productivity within each trophic level will vary considerably, ranging from no measureable effect to greater than the potential stimulatory effect of the nutrients. In all of the following calculations on potential productivity resulting from wastewater nutrients, the possible negative effects of toxicants have not been considered. Thus, the results below may well be substantial overestimates of the biomass production resulting from sewage derived nutrients.

- Potential Influence of Inorganic Nitrogen from HTP on Primary Productivity and the Fishery. In 1974 HTP introduced 6,640 metric tons of inorganic nitrogen, mostly in the form of ammonia, through its 5-mile outfall and 1,952 metric tons of inorganic nitrogen, nearly all in the form of ammonia, through its 7-mile outfall (sludge). Figure III-C-37 shows a schematic representation of the potential fate of this nitrogen. It is assumed that all of the nitrogen was assimilated, and that its distribution in the various trophic levels of the marine food web was proportional to an approximation of the distribution of organisms (by biomass) in the food web. The approximation used was that the standing crop at each successively higher trophic level was 10 percent of the biomass at the previous level. Also included are the assumptions that phytoplankton are 2 percent nitrogen (wet weight), and that all other organisms are 3 percent nitrogen (wet weight). The former is based on a dry weight nitrogen content of 2 to 8 percent (usually closer to 8 percent if not nitrogen limited) and an approximate water content of 75 percent for phytoplankton (Ward, 3 June 1976). Zooplankton vary from 1.3 to 13 percent nitrogen (dry weight) depending on species, and 3 percent (wet weight) was used in this analysis. The resulting analysis shows a maximum production of fish resulting from the addition of inorganic nitrogen

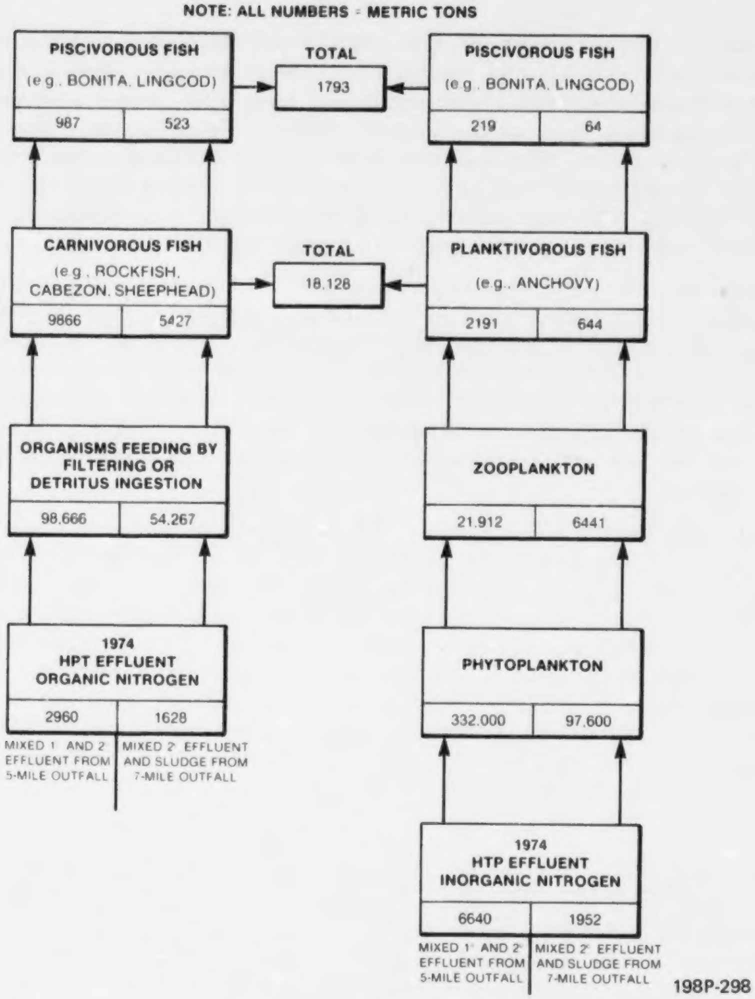

NOTE: ALL NUMBERS = METRIC TONS
PISCIVOROUS FISH
(e.g., BONITA, LINGCOD)
987
523
TOTAL
1793
PISCIVOROUS FISH
(e.g., BONITA, LINGCOD)
219
64
CARNIVOROUS FISH
(e.g., ROCKFISH, CABEZON, SHEEPHEAD)
9866
5427
TOTAL
18,128
PLANKTIVOROUS FISH
(e.g., ANCHOVY)
2191
644
ORGANISMS FEEDING BY FILTERING OR DETRITUS INGESTION
98,666
54,267
ZOOPLANKTON
21,912
6441
1974
HPT EFFLUENT
ORGANIC NITROGEN
2960
1628
MIXED 1° AND 2° EFFLUENT FROM 5-MILE OUTFALL
MIXED 2° EFFLUENT AND SLUDGE FROM 7-MILE OUTFALL
PHYTOPLANKTON
332,000
97,600
1974
HTP EFFLUENT
INORGANIC NITROGEN
6640
1952
MIXED 1° AND 2° EFFLUENT FROM 5-MILE OUTFALL
MIXED 2° EFFLUENT AND SLUDGE FROM 7-MILE OUTFALL
198P-298

Figure III-C-37. Hypothetical trophic structure pyramids of standing crop (biomass in metric tons) showing a potential distribution of wastewater derived nitrogen at each trophic level. It is assumed that all of the nitrogen discharged by HTP enters organisms (rather than some being buried in the sediments or denitrified by bacteria and lost to the food chain), that all organisms contain 3 percent nitrogen by weight (wet) except phytoplankton which is assumed to contain 2 percent, and that biomass at each level is 10 percent of the previous level. Based on these assumptions, the figure shows that the 1974 HTP nitrogen discharge could account for an annual production of 18,128 metric tons of lower trophic level fish (for example; anchovies, rockfish, cabezon, and sheephead) or 1,793 metric tons of piscivorous fish (bonito, tuna, lingcod, halibut, and shark). A minimal number of trophic levels were used between the introduced nitrogen and the harvestable fish to show maximal effects. Thus, this is an extremely optimistic estimate of the beneficial effects of HTP nitrogen. A more detailed explanation of the assumptions and validity of these calculations is presented in the text.

of either 2,835 or 283 metric tons of fish (depending on the trophic level) per year. This is a substantial weight of fish, but still represents less than 3 percent (low trophic level fish) or 0.3 percent (top trophic level fish) of the 1972 commercial fish catch of 92,879 metric tons brought into Los Angeles Harbor (see Table III-C-14). Not all of the fish produced may be commercially (or recreationally) valuable species thus reducing these percentages by some unknown factor.

The reliability of this estimate is questionable since it is difficult to verify any of the assumptions used. The estimated percentage of nitrogen in various organisms is probably accurate within a factor of two. The distribution of nitrogen, once it gets into the food chain through phytoplankton, is seasonably variable and highly dependent on the particular food chain being examined. The scheme presented here is not unreasonable, but it could be off by two orders of magnitude for some of the transfers. For example, the standing crop of zooplankton at times could be 10 times that of phytoplankton rather than one tenth of it, and the amount of nitrogen stored in planktivorous fish could be much greater than 10 percent of that stored in zooplankton. As information on standing crops in the Southern California Bight is accumulated, the distribution of biomass will become better defined. The assumption that all of the inorganic nitrogen released to the water ultimately ends up in phytoplankton is least defensible. Some of the inorganic nitrogen is certainly denitrified by bacteria and lost to the water column as dissolved nitrogen gas. The inorganic nitrogen, to be utilized by phytoplankton, must rise to the euphotic (light) zone where phytoplankton live. Much of the inorganic nitrogen, particularly that associated with sludge particulates, probably remains below the thermocline and out of the light zone. Upwelling may bring at least part of this nitrogen to the surface periodically.

Finally, although nitrogen is often a factor limiting plankton growth in marine ecosystems, the addition of a small amount of nitrogen may be sufficient to cause some other factor to become limiting. Dunstan (1975) has shown that even when nitrogen of sewage origin was presented to laboratory cultures of phytoplankton, the phytoplankton failed to grow to predicted levels, apparently because of other nutrient deficiencies in some cases, and the presence of toxic metals along with the nitrogen in others. There is evidence that phytoplankton growth is enhanced near the HTP outfall, but most of the relevant data taken by Hyperion Treatment Plant over the 14 years from 1957 through 1970 remain unanalyzed, and the magnitude of the enhancement is unknown.

- Potential Influence of Organic Nitrogen from HTP on the Primary Productivity and the Fishery. Figure III-C-37 also shows a hypothetical distribution of the organic nitrogen released from the 5-mile and 7-mile outfalls of the Hyperion Treatment Plant. The following assumptions made for this calculation are less reliable than the assumptions made for the inorganic nitrogen. It is assumed that the organic nitrogen is assimilated directly by organisms larger than zooplankton - either detritus-feeding or filter-feeding macroinvertebrates - and that these organisms are then eaten directly by fish. It is equally reasonable to assume that zooplankton are the first trophic level involved, which would alter the ultimate fish species benefited, but which would not alter the resulting productivity. The analysis shows that organic nitrogen additions could result in an increase of 15,293 metric tons of carnivorous fish or 1,510 metric tons of piscivorous fish per year. These are equal to approximately 16 percent (lower trophic level fish) and 1.6 percent (top carnivores) of the 1972 commercial fish catch brought into Los Angeles Harbor. This analysis is subject to the same uncertainties as the inorganic nitrogen analysis and probably overestimates the final benefits of nitrogen added by Hyperion Treatment Plant.

- Effects of Total Nitrogen Inputs. The potential increase of planktivorous and carnivorous fish that could result from the annual total nitrogen additions from HTP is 18,128 metric tons and is summarized in Figure III-C-38. The total increase of top carnivores, the piscivorous fish, is 1,793 metric tons. These figures represent 19.5 percent and 2 percent of the total 1972 commercial fish catch brought into Los Angeles Harbor. Of the potential total increases, the 7-mile effluent (primarily sludge) contributes one third.

It should be emphasized again that these figures are optimistic. First, it is quite possible that most of the nitrogen is transported to the deep ocean basins where it is deposited in the sediments, or where it recycles in food chains that do not include fish (or fish of commercial value). Second, it is likely that much of the nitrogen discharged into the water column is subsequently transported out of the Los Angeles area, and out of the Southern California Bight. Were that the case, then the increases in potential fishery production should be compared not to the Los Angeles Harbor catch, but to some larger catch; the West Coast catch or the Pacific Ocean catch, for example.

- Potential Influence of Phosphate from HTP on Primary Productivity and the Fishery. The mass emissions of inorganic phosphate are greater than those of inorganic nitrogen. The phytoplankton probably benefit from the phosphate in the sense that if it were not available along with the nitrogen, then it could become the limiting factor. An analysis like that for inorganic nitrogen could be made and the results would be similar.

- Potential Influence of Organic Carbon from HTP on the Fishery. Organic carbon is made up of proteins, carbohydrates, ether extractable substances, tannins and lignins, detergents, and humic substances. The mass emission rates of organic carbon can be calculated from the mass emission rates of volatile solids given in Table III-B-2 by the formula (from SCCWRP, 1975a):

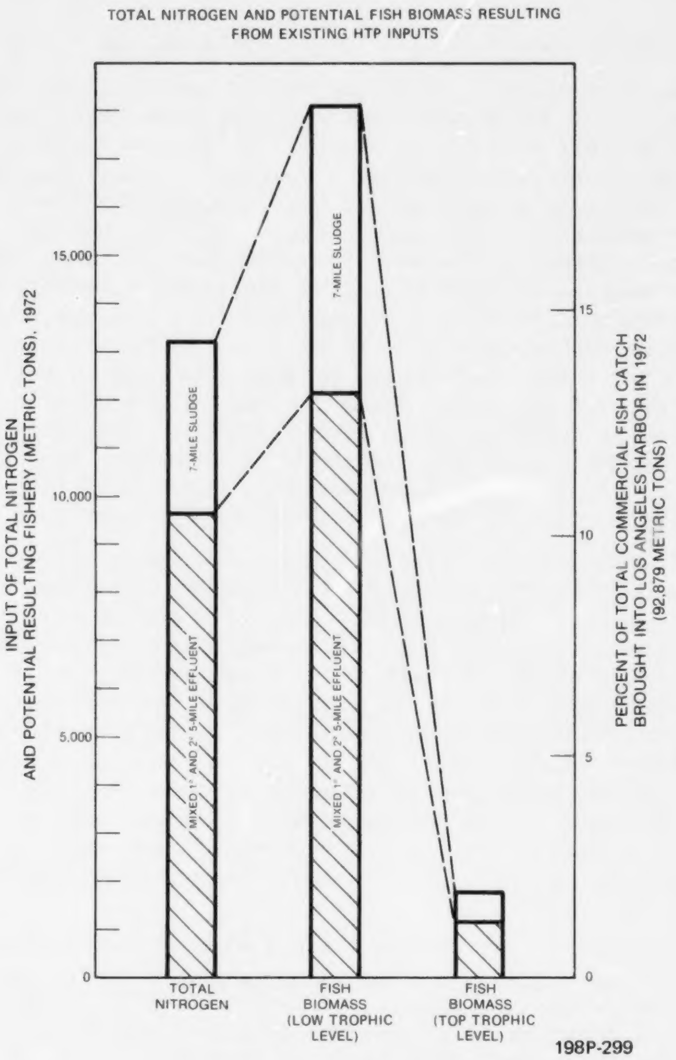


Figure III-C-38. This figure is a summary of Figure III-C-37 and shows the maximum potential contribution of Hyperion Treatment Plant nitrogen (organic + inorganic) to the fishery. Also shown is the percentage of the 1972 commercial fish catch brought into Los Angeles Harbor that could have been composed of fish attributable to Hyperion Treatment Plant nitrogen. This figure presents an optimistic view of the beneficial effects of nitrogen contained in HTP effluent.

% organic carbon = 0.484 (% volatile solids - 1.86)

and amounts to a total of 14,692 metric tons per year from the 5-mile effluent and 14,373 metric tons per year from the 7-mile effluent in 1974. These values are similar to Meyer's (1974) measurements showing that sewage particulates are approximately 34 percent organic carbon. This total organic carbon mass emission of 29,065 metric tons/year, 92 percent of which is associated with particulates (SCCWRP, 1975a), is available as a food source primarily to benthic organisms living in the sediments or attached to hard substrates and to zooplankton capable of ingesting suspended particulates. If it is assumed that all the energy contained in the organic carbon compounds is utilized by benthic invertebrates sufficiently large to be eaten by fish (an example being the polychaete worm, *Capitella capitata,* which thrives in the organic sludge deposits of the 7-mile outfall), then Figure III-C-39 indicates that the potential maximum production of top carnivore is 29 metric tons per year or 0.03 percent of the 1972 Los Angeles Harbor commercial fish catch. The same result would occur if the organic carbon were utilized first by zooplankton.

If, as it is alternatively shown in Figure III-C-39, the organic carbon were first utilized by bacteria, the resulting top carnivore biomass would be an order of magnitude lower (2.9 metric tons) or 0.003 percent of the commercial catch. It is probable that part of the organic carbon passes through each of these food chains and others as well. The pathway is somewhat dependent on the initial distribution of the particulates of which a certain percentage immediately settles to the sediments. For the JWPCP Whites Point outfall the latter has been estimated to be less than 1 percent of the total particulates based on a hypothesis that once the organic carbon reaches the sediments it is not mobilized (Morel et al., 1975) and a mass balance of accumulated carbon near the outfall that shows only 0.5 percent of the total sewage organic carbon can be accounted for (Meyers, 1974).

As discussed in Section III.B.2.a(6), the hypothesis that very little of the volatile solids is accumulated in the sediments is supported for the Hyperion Treatment Plant 5-mile outfall. But at the 7-mile outfall, a much larger percentage of the volatile solids is accumulated in the sediments, and this has been estimated at 37 percent (SCCWRP, 1975a) or higher (this report). At the HTP outfalls, then, it is reasonable to estimate that half of the organic carbon from the 7-mile outfall is available for a total of 75 percent of the total organic carbon released by the plant. Thus, the final values on Figure III-C-39 could be reduced by 25 percent to reflect accumulation in the sediments.

(3) UPTAKE, TOXICITY, AND BIOACCUMULATION OF SEWAGE CONSTITUENTS IN FISH.

(a) Chlorinated Hydrocarbons in Fish Near Sewage Outfalls. In November 1972, HTP conducted two trawls near the 5-mile outfall and two at

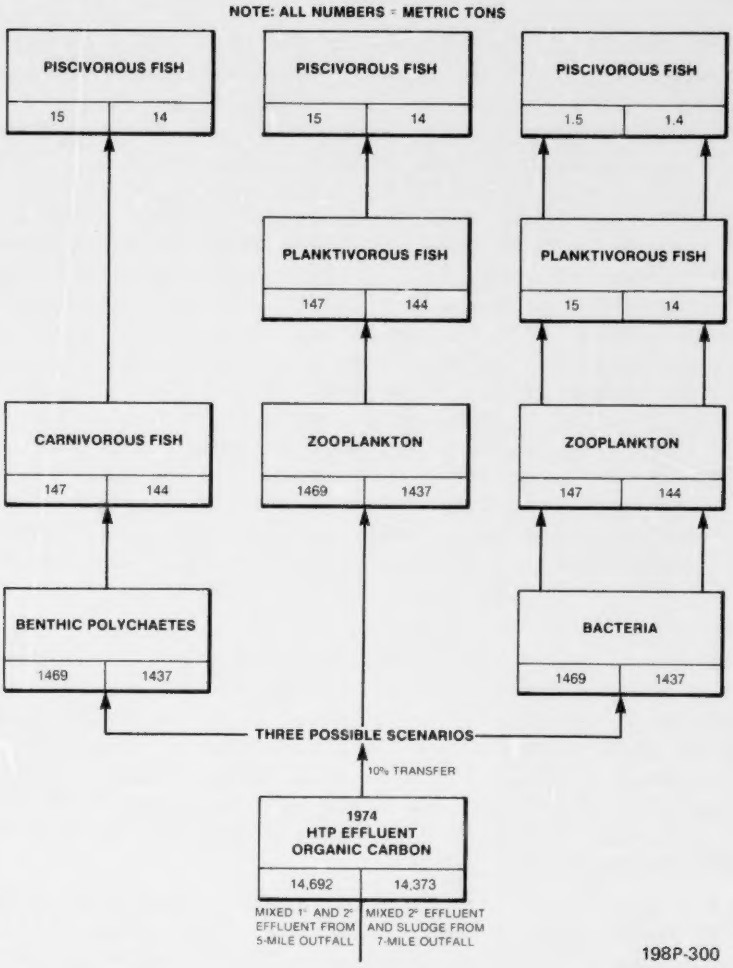

NOTE: ALL NUMBERS = METRIC TONS
PISCIVOROUS FISH
15
14
PISCIVOROUS FISH
15
14
PISCIVOROUS FISH
1.5
1.4
PLANKTIVOROUS FISH
147
144
PLANKTIVOROUS FISH
15
14
CARNIVOROUS FISH
147
144
ZOOPLANKTON
1469
1437
ZOOPLANKTON
147
144
BENTHIC POLYCHAETES
1469
1437
BACTERIA
1469
1437
THREE POSSIBLE SCENARIOS
10% TRANSFER
1974
HTP EFFLUENT
ORGANIC CARBON
14,692
14,373
MIXED 1° AND 2° EFFLUENT FROM 5-MILE OUTFALL
MIXED 2° EFFLUENT AND SLUDGE FROM 7-MILE OUTFALL
198P-300

Figure III-C-39. Three of many possible trophic pathways by which the particulate organic carbon in the effluent from Hyperion Treatment Plant could reach the top carnivore population. It is assumed that all of the organic carbon enters organisms and that the transfer efficiency from one trophic level to the next is 10 percent. Based on these assumptions, the figure shows that the organic carbon in the 1974 HTP effluent could produce a maximum of 29 metric tons/year of piscivorous fish, such as lingcod, bonito, mackerel, and shark. The maximum production of carnivorous fish (e.g., rockfish, cabezon, and white croaker) and planktivorous fish (anchovies) would be 291 metric tons/year. A minimal number of trophic levels were used in the calculations to show the maximal effects. A more detailed discussion of the assumptions and validity of these calculations is presented in the text.

a control station at the same depth (60 m). Total identifiable chlorinated hydrocarbons (TICH), metals, and radioactivity (total β-activity) were measured in tissues from some of the fish collected. The TICH included lindane, heptachlor, heptachlor epoxide, o,p'-DDE, dieldrin, o,p'-DDD, o,p'-DDT, p,p'-DDT, Aroclor 1242, and BHC. Figure III-C-40 shows the concentration of TICH in the muscle and liver tissues of fish species (one fish each) collected near the 5-mile outfall and at the control station. These data show that TICH are accumulated in the flesh and liver tissue of fish, especially in the vicinity of the outfall. The amount accumulated is species specific with yellowchin sculpin the highest and plainfin midshipman the lowest of the species measured. The concentrations measured in the muscle were all below the FDA standard of 5 mg/wet kg (ppm) in edible tissue while most of the liver tissue concentrations, especially from the outfall area, exceeded this standard considerably. However, many fish (replicates) must be analyzed before the levels in each species can be accurately determined. The much higher concentrations in the liver are as expected since chlorinated hydrocarbons are highly soluble in lipids and practically insoluble in water, and the liver is a lipid storage organ. High concentrations would also be expected in the muscle of fish with high lipid content such as anchovies and sardines.

The PCB's found in organisms and the environment are generally of two chemical forms, one chromatographically similar to Aroclor 1254 (54 percent chlorination by weight) and one similar to Aroclor 1242 (42 percent chlorination by weight). Of the total PCB's released in wastewater discharges approximately two-thirds resemble Aroclor 1242 and the remainder resemble Aroclor 1254. In Dover sole muscle samples taken in 1974-75 the concentrations of the two PCB types were reversed with two-thirds of the PCB's found resembling Aroclor 1254 and one-third resembling Aroclor 1242 (McDermott et al., 1975).

The highest concentrations of DDT and PCB's were found in the muscle tissue of Dover sole collected near the JWPCP, Hyperion Treatment Plant, and Orange County Sanitary District outfalls (SCCWRP, 1973). The values were significantly higher than those for fish collected at Santa Catalina Island and in areas up the coast towards Port Hueneme. The JWPCP (Whites Point) outfall system has been a major point source of chlorinated hydrocarbons in the past, and concentrations of DDT in the sediments reflect this. Black perch collected in 1971 and 1972 off Palos Verdes contained 0.61 to 64.0 mg/wet kg of DDT while kelp bass contained 0.77 to 47.0 mg/wet kg (SCCWRP, 1973). Seventy-five percent of the composite samples of muscle tissue from Dover sole collected during 1971 and 1972 between Redondo Canyon and the western entrance of Los Angeles Harbor exceeded the 5 ppm (mg/wet kg) standard set by the United States Food and Drug Administration (FDA) as the maximum allowable DDT in fish for sale (SCCWRP, 1974). DDT concentrations in excess of the standard have also been reported for white croaker taken at the Los Angeles breakwater (Castle and Woods, 1972). Approximately 50 percent of the kelp bass and black perch collected off Palos Verdes in 1973 exceeded the FDA standard for DDT (5 ppm) (Table III-C-18). Laboratory experiments using the thorny skate have shown that carbon-14 labeled p,p'-DDT given as a continuous infusion or

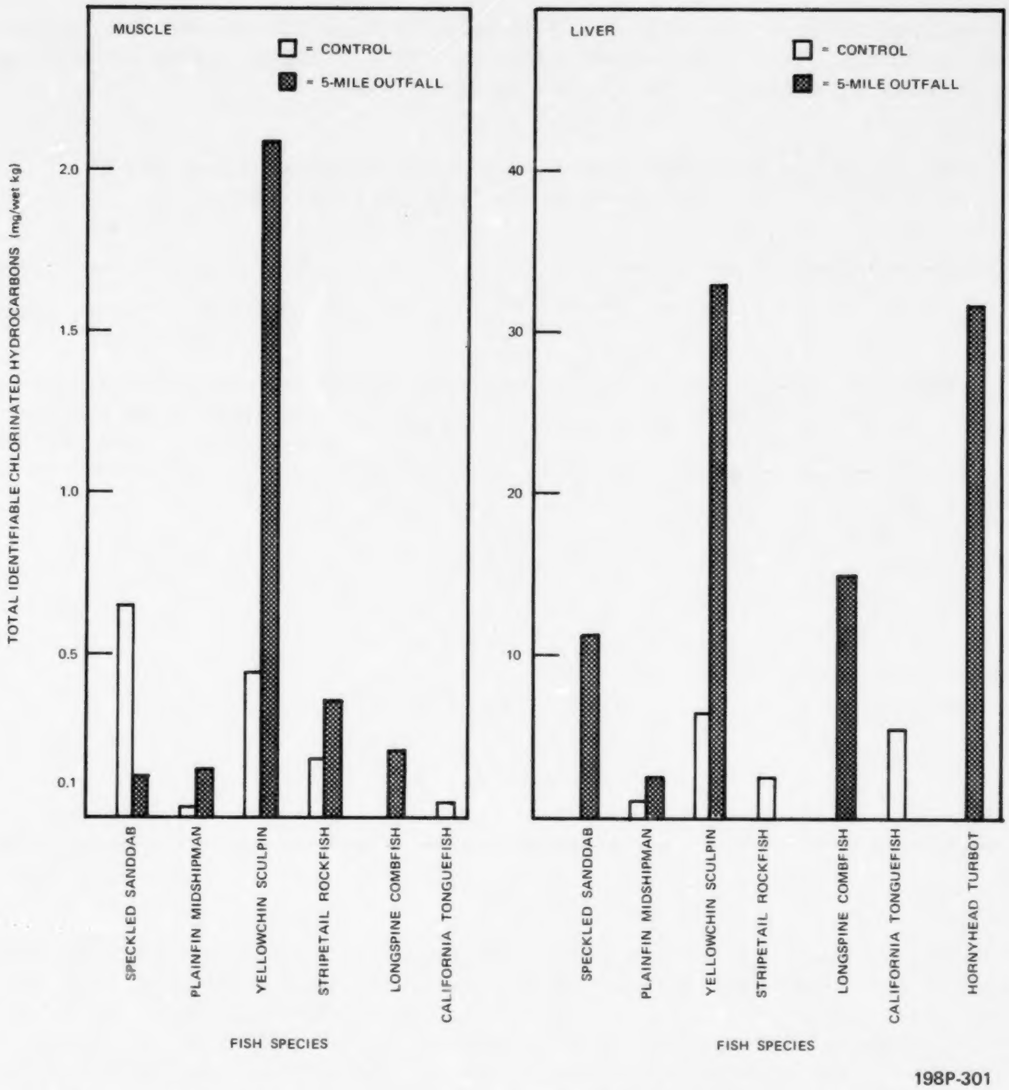


Figure III-C-40. Concentrations of TICH in the muscle and liver tissues of fish species collected near the HTP 5-mile outfall and at a control station in 1972. Absolute values are much higher in the liver than in the muscle, and there are differences between species. Only one fish of each species was sampled so that the data cannot be interpreted as reflecting real differences between species (data from DPW, 1973).

as an intravenous injection was lost rapidly from the plasma and stored mainly in the liver (Darrow and Addison, 1973). There was no significant metabolism or excretion of the DDT in three weeks.

Table III-C-18. Total DDT in the flesh of fish caught off Palos Verdes in 1973 (SCCWRP, 1974).

SPECIES	DDT CONCENTRATION IN FISH MUSCLE (mg/wet kg)			FEDERAL LIMIT (5 ppm) EXCEEDED	
	NUMBER OF FISH	MEDIAN	RANGE	NUMBER OF FISH	PERCENT OF FISH TESTED
Black perch	60	7.9	0.82 - 87	39	65
Kelp bass	28	4.0	0.37 - 29	13	46
Dover sole	4	4.0	2.6 - 13	1	25
Greenstriped rockfish	5	46.0	21.0 - 330	5	100
Miscellaneous	3	4.0	1.3 - 11	1	33
TOTAL	100			59	59

The accumulation of PCB's in fish tissue is similar to that for DDT. Black perch from Palos Verdes contained 0.35 to 43.0 mg/wet kg (ppm) and kelp bass contained 0.1 to 6.0 mg/wet kg (ppm)(SCCWRP, 1973). The mean concentrations of PCB in Dover sole muscle tissue collected in 1971-72 and 1974-75 are presented in Table III-C-19 for several location in the Bight. The values for fish from wastewater discharge areas are significantly higher than those in fish from non-discharge areas. Four fish from the Orange County outfall area in 1974-75 exceeded the FDA action level of 5 ppm (mg/wet kg) PCB in fish and shellfish for human consumption. In 1975 the concentrations of PCB in Dover sole liver tissue from the Palos Verdes area was much higher than that in the muscle, gonad, heart, or kidney tissue (McDermott et al., 1975).

Table III-C-19. Mean PCB concentrations in Dover sole muscle tissue from wastewater outfall and non-outfall areas in 1971-72 and 1974-75 (from McDermott et al., 1975).

LOCATION	MEAN CONCENTRATION (mg/wet kg)	
	1971-72	1974-75
Port Hueneme	0.098	0.060
Santa Monica[1]	1.6	1.9
Palos Verdes[1]	2.4	1.4
Orange County[1]	0.63	1.2
Dana Point	0.13	0.25
Santa Catalina Island	0.039	0.081

[1] Wastewater outfall areas

(b) Heavy Metals and Fish Near Sewage Outfalls. The relationship between the concentration of metals in the environment and their concentration in fish tissues has been examined by sampling fish from areas of high and low metal concentration in the sediments.

The average concentrations of eleven trace metals in liver tissue from Dover sole collected in areas of natural to very high concentrations of metals in sediments are shown in Table III-C-20. The concentrations of silver, copper, iron, mercury, antimony, and zinc are not significantly different in the livers of fish caught in areas of very high sediment metal concentrations when compared to the livers of fish caught in areas of natural sediment metal concentrations. Paradoxically, the concentrations of arsenic, cadmium, cobalt, molybdenum, and selenium are significantly lower in the livers of fish caught in areas of high sediment metal concentrations than in the livers of fish from areas of natural sediments. The average values for metals in Dover sole liver are generally comparable to the concentrations reported for fish from the Atlantic and Pacific Oceans (Table III-C-21).

In another study (SCCWRP, 1974) seven metals were analyzed in the muscle, liver, and gonads of Dover sole from the Santa Barbara Channel (control) and near the JWPCP outfall (contaminated). The ratio of outfall to control sediment concentration for each metal as well as the values for the three tissues at each sampling location are presented in Table III-C-22.

Table III-C-20. Concentration of heavy metals in Dover sole liver tissue and surface sediments collected in southern California waters (from SCCWRP, 1973).

METAL	SUBSTANCE TESTED	CONCENTRATION[1]		p[2]
		NATURAL	VERY HIGH	
Ag	liver	3.0	2.1	$p>0.30$
	sediment[3]	1.0	3.0	
As	liver	3.1	1.3	$p<0.001$
	sediment	---	---	
Cd	liver	0.58	0.19	$0.001<p<0.01$
	sediment	0.37	59.0	
Co	liver	0.06	0.04	$0.001<p<0.01$
	sediment	7.2	7.6	
Cu	liver	2.2	2.0	$p>0.30$
	sediment	16.0	360.0	
Fe	liver	180.0	210.0	$p>0.30$
	sediment	25,000	30,000	
Hg	liver	0.11	0.11	$p>0.30$
	sediment	0.05	3.4	
Mo	liver	0.13	0.08	$0.01<p<0.02$
	sediment	---	---	
Sb	liver	0.0034	0.0029	$p>0.30$
	sediments	---	---	
Se	liver	1.2	0.64	$0.001<p<0.01$
	sediment	---	---	
Zn	liver	27.0	26.0	$p>0.30$
	sediment	63.0	1,100.0	

[1] Concentrations in mg/wet kg for liver tissue and mg/dry kg for the sediments. The sample sites were areas of natural and very high metal concentrations in the sediments.

[2] p = probability that the differences in the values from the natural and very high areas occurred by chance

[3] Sediment concentrations are estimated averages

Table III-C-21. Trace metal concentrations in liver tissues of Atlantic and Pacific Ocean fin fish and southern California Dover sole (SCCWRP, 1973).

FISH	CONCENTRATIONS (mg/wet kg)											
	Ag	As	Cd	Co	Cr	Cu	Fe	Hg	Mo	Sb	Se	Zn
False Albacore[1]	-	0.9	0.6	-	-	0.9	-	0.3	-	-	-	50
Spanish Mackerel[1]	-	0.7	0.1	-	-	0.8	-	0.1	-	-	-	8
Unidentified Grouper[1]	-	0.5	0.8	-	-	9	-	1.1	-	-	-	25
Salmon[2]												
Chum	1.0	-	-	0.02	< 0.005-0.14	-	150	0.1	-	< 0.0003	5	25
Coho	0.06	-	-	0.04	< 0.005	-	110	0.1	-	0.0004	1	25
King	0.08	-	-	0.01	< 0.005-0.12	-	100	0.1	-	0.0004	1	30
Pink	0.25	-	-	0.01	< 0.005-0.01	-	100	0.1	-	0.006	1	40
Sockeye	1.5	-	-	0.01	< 0.005-0.12	-	80	0.1	-	0.006	10	25
Skipjack Tuna[3]	-	-	-	-	-	-	-	0.2	-	-	-	-
Sea Bass[3]	-	-	-	-	-	-	-	0.7	-	-	3	60
Albacore[3]	-	-	-	-	-	-	-	0.2-0.9	-	-	8-19	33-52
Calico Bass[4]	0.005	-	6	0.5	0.38	1.5	180	-	0.1	-	-	30
Dover Sole (Bight Avg.)	4.2	1.6	0.32	0.04	(~0.05)	2.6	190	0.14	0.09	0.0026	0.83	27

[1] From Windom (1972). Wet-weight values obtained from original dry-weight values assuming a wet/dry ratio of 4.0.

[2] From Robertson et al., (1972). Wet-weight values obtained from original dry-weight values using the wet/dry ratio of 4.2 listed by the authors for Chum Salmon liver.

[3] From Kinshore and Guinn (1972).

[4] From Stapleton (1968). Wet-weight values obtained from original dry-weight values assuming a wet/dry ratio of 4.0.

Table III-C-22. Estimated sediment enrichment and median concentrations of 7 metals in tissues from Dover sole trawled near the JWPCP outfalls and from a control area in the Santa Barbara Channel (SCCWRP, 1974).

METAL	SEDIMENTS	FLESH (mg/dry kg)[1]		GONAD (mg/dry kg)[1]		LIVER (mg/dry kg)[1]	
	OUTFALL TO CONTROL RATIO	OUTFALL	CONTROL	OUTFALL	CONTROL	OUTFALL	CONTROL
Silver	3.2	0.2	0.1	<0.1	0.3	0.4	0.5
Cadmium	150	<3.0	<3.0	<3.0	<3.0	3.3	6.4
Chromium	16	<0.2	<0.2	0.4	<0.2	0.4	<0.2
Copper	20	0.6	0.5	10.7	12.7	7.4	9.5
Nickel	2.4	<2.0	<2.0	<4.8	<2.0	2.6	1.4
Lead	52	1.3	<1.1	<1.0	<1.0	5.0	4.5
Zinc	12	39.4	38.0	214	233	91.8	108

[1] To obtain concentrations in mg/wet kg divide the values reported by 4.0.

In the fish tissue only the chromium concentration was significantly (95 percent confidence level) higher in the liver of fish collected near the outfall. The effects of this increase on the fish, however, are unknown. The concentration of cadmium in the liver and silver in the gonads was significantly lower in fish caught near the outfall, but the reasons are unknown (SCCWRP, 1974). The concentrations of silver in muscle, nickel in liver, and chromium in gonad were higher (but not significantly so) in fish caught near the outfall than in the control fish.

Many hypotheses may be put forth to explain the low concentration of metals in fish from the immediate vicinity of large wastewater discharges as compared to fish from a control area. Two possibilities are that (1) the higher than normal total chlorinated hydrocarbon concentration in the liver of fish from near the outfalls causes a reduction in the uptake of metals from the environment and (2) the metals ingested in or with food organisms are not absorbed in the gastrointestinal tract because of the chemical form of the metals and the physiology of the absorptive tissues. No data presently exist, however, to confirm or refute either of these hypotheses.

Dover sole accumulate trace metals in various tissues at differing rates as can be seen in Table III-C-22. In the three tissues analyzed, the control fish concentrated zinc in the gonads and liver, lead in the liver, copper in the gonads and liver, cadmium in the liver, and silver in the liver and gonads. In fish caught near the outfall, zinc, lead, copper, and cadmium were concentrated in the same tissues as the control fish. In addition, silver was concentrated in the liver and muscle, chromium in the gonads and liver, and nickel in the gonads.

Mercury is the only metal for which there is an FDA standard for the edible parts of fish and shellfish, and this standard is 0.5 ppm (mg/wet kg). In the Southern California Bight, the concentrations reported for Dover sole liver (non-edible tissue) have not exceeded this level. The concentrations of mercury in species present in the Los Angeles area have been reported from several locations, and those for Santa Monica Bay are discussed below. A number of species from the coast of Oregon (area of few sewage outfalls) have also been tested for mercury (Childs and Gaffke, 1973). Rex sole, Dover sole, petrale sole, English sole, sand sole, starry flounder, canary rockfish, flag rockfish, yellowtail rockfish, rougheye rockfish, sablefish, lingcod, Pacific hake, and arrowtooth flounder had significantly less than 0.5 ppm while all of the spiny dogfish sampled contained more than 0.5 ppm. There was no relationship between concentration and size, sex, weight and length, or location.

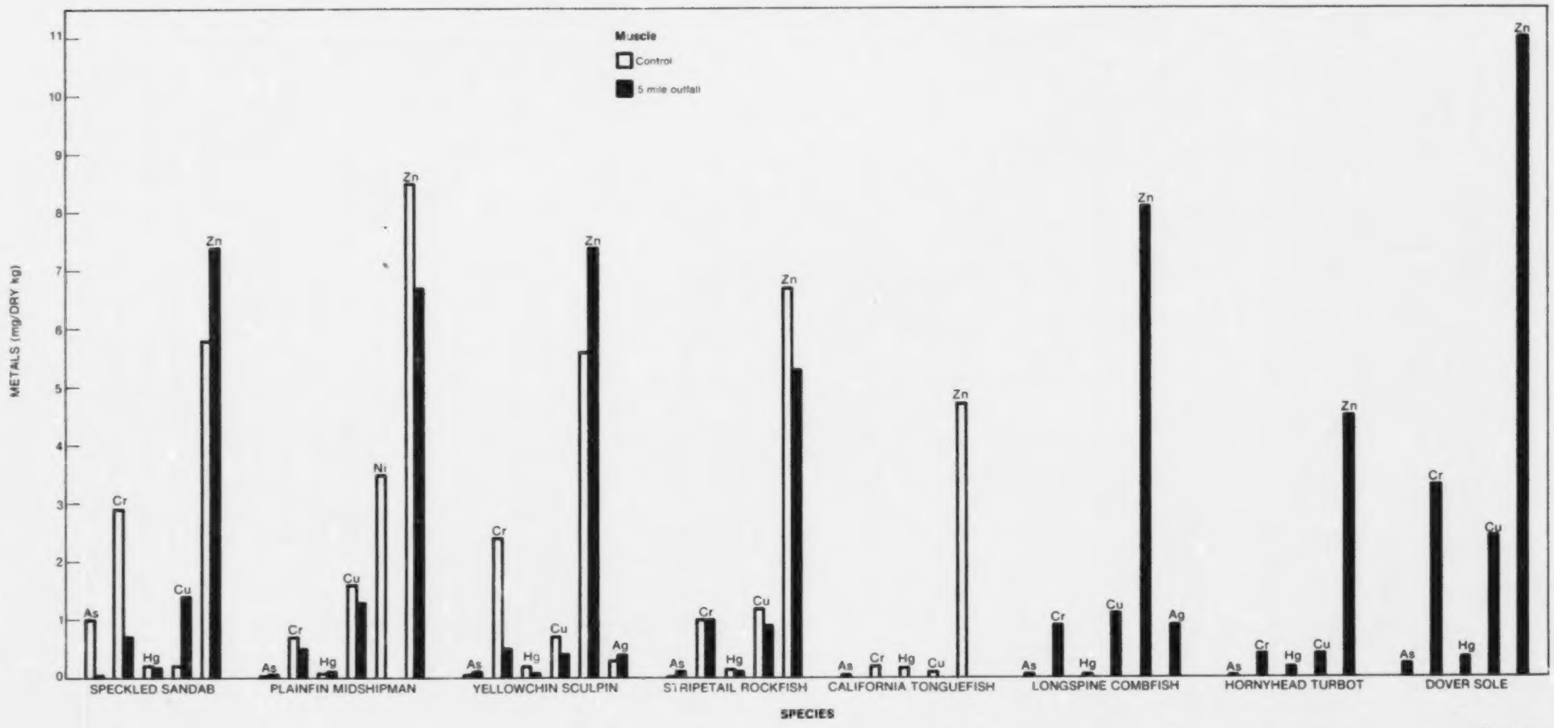
Frozen swordfish steaks have been reported to have 0.49 to 2.60 ppm of total mercury of which 93-113 percent was methylmercury, and canned tuna to have 0.04 to 0.55 ppm of total mercury of which 90 to 125 percent was methylmercury (Kamps et al., 1972). The values of methylmercury over 100 percent were a result of analytical techniques. Although most of the mercury in fish tissue is in the methyl form, fish are not known to methylate mercury. Thus, methylation must occur prior to ingestion by the fish (Jensen and Jernelov, 1972).

- Heavy Metals in Fish Near the HTP Outfalls. Several trawl surveys were conducted in Santa Monica Bay during 1972. In September SCCWRP conducted a synoptic trawl survey at the Hyperion, JWPCP, and Orange County outfalls (Mearns et al., 1974). The data suggest that the effects of the wastewater discharges are limited to within 2 to 3 km of the outfalls. Metals were not found to be concentrated in Dover sole near HTP outfalls, although PCB and DDT concentrations were higher in the flesh of Dover sole taken near the outfall than in those from other areas in Santa Monica Bay.

Figures III-C-41 and 42 show the concentrations of metals in the muscle and liver for several species of fish collected in the November 1, 1976 HTP survey. The data do not indicate an accumulation of metals in either the muscle or liver tissue of fish collected near the 5-mile outfall compared to those from the control station located 9.7 km (6 mi) northwest of the outfall station. Similar results were reported by SCCWRP (1973) for Dover sole from an outfall area compared to a control area. The concentration of metals in fish tissue is species-specific and also varies for each metal. Arsenic, copper, zinc, and silver are generally accumulated in the liver much more than in the flesh while the distribution of the other metals in the tissues varies with species. Nickel and silver concentrations were generally below the levels of detection and the concentration of lead was always below the level of detection in all the species tested.

Radioactivity, counted as total β-activity, was measured in whole fish samples from the 5-mile outfall and control areas. The β counts were always higher in the fish from the 5-mile outfall station than in fish from the control station. The data, however, are insufficient to statistically test this difference for significance.

- Direct Toxicity of Sewage Constituents to Fish. Table III-C-3 shows lethal and sublethal effects of DDT on fish as determined in laboratory studies. The concentrations of DDT in the 1974 HTP effluent and sludge are at least one order of magnitude less than aqueous concentrations known to cause direct lethal or sublethal effects on killifish, American eels, *Pleuronectes platessa,* and grunion fry. The undiluted effluents are both toxic to dwarf perch and small striped bass while only the sludge may be lethal to shiner perch. The latter three fish, however, are shallow water species so that exposure would be only to diluted effluent which would not produce lethal effects. The concentrations of heavy metals in water that have been determined in laboratory experiments to have toxic effects on fish are presented in Table III-C-3. The undiluted concentrations of substances in the 1974 HTP 5-mile effluent may produce lethal and sublethal effects in several species of fish: ammonia is lethal to dogfish, copper is sublethal to winter flounder, and silver is sublethal to killifish. The concentrations of the constituents in the undiluted 7-mile effluent may cause lethal or sublethal effects for copper, mercury, silver, zinc, and ammonia. The species tested in these bioassays, however, do not normally occur near the HTP outfalls, so would



198P-302

Figure III-C-41. Concentration (mg/dry kg) of heavy metals in the muscle tissue of fish collected near the HTP 5-mile outfall and at a control area at the same depth on 1 November 1972 (data from DPW, 1973).

not be exposed to undiluted effluent. Extrapolation of toxic effects from these species to other related species is not possible since the effects are very species-specific.

(4) DISEASES AND ABNORMALITIES OF FISH.

(a) Tumors. Tumor-like growths (Figure III-C-43) have been reported for at least 10 species of flatfish from along the Pacific coast of North America (Mearns and Sherwood, 1974), but there is no indication that they

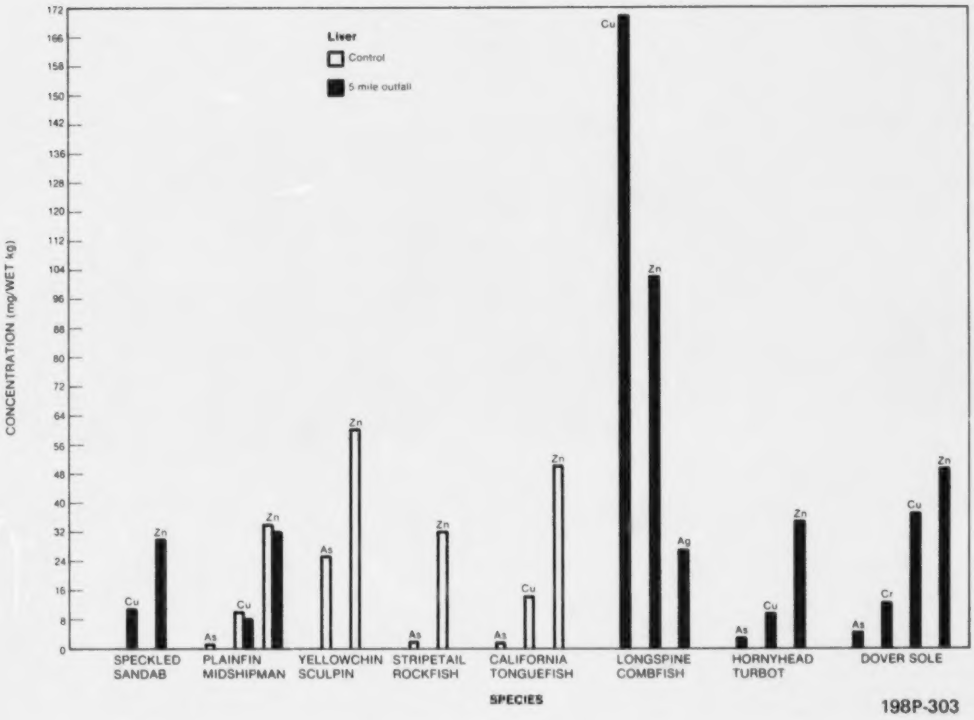
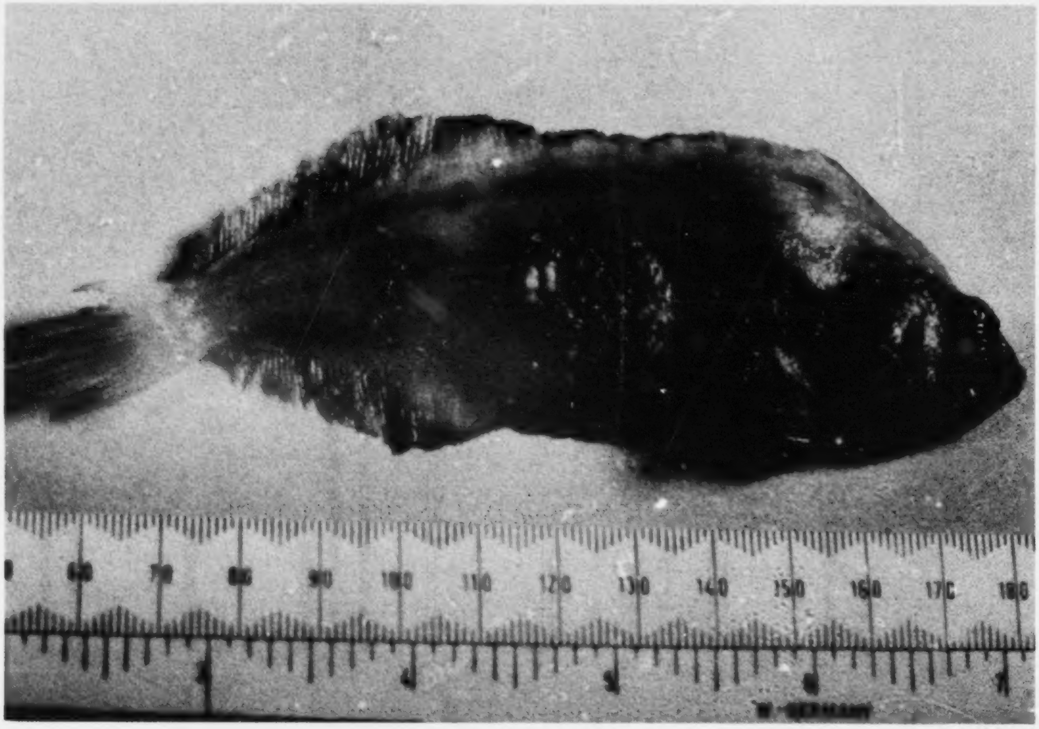


Figure III-C-42. Concentration (mg/dry kg) of heavy metals in the liver tissue of fish collected near the HTP 5-mile outfall and at a control area at the same depth on 1 November 1972 (data from DPW, 1973).

can be attributed to sewage effluents. In a 1969-1972 trawling survey in southern California waters, tumors were found on Dover sole, slender sole, hornyhead turbot, and California tonguefish with the highest incidence of tumors (1.3 percent) in small Dover sole (SCCWRP, 1973). During the 1972-1973 trawls, tumors were found on nine species of fish with Dover sole being affected most frequently (SCCWRP, 1974). The incidence in Dover sole collected off Palos Verdes was 1.0 percent for all sizes and up to 15.6 percent for small individuals. In the 1974 trawls (SCCWRP, 1975a) five species of tumor-bearing fish were collected, and the incidence in Dover sole was 0.5 percent.



198P-304

Figure III-C-43. Large epidermal papilloma (tumor-like growth) on the eyed side of a Dover sole collected from the Palos Verdes Peninsula (photograph courtesy of SCCWRP).

Tumors occur most frequently in small Dover sole ranging from 60 to 120 mm standard length, and the number of tumors per fish varies from 1 to 10 with an average of 1.8 (Mearns and Sherwood, 1974). The smallest tumors were found on the smallest fish and the largest on the largest fish. Based on preliminary histopathological examinations, these growths include angioepithelial nodules and epidermal papillomas. The ultimate effect of these tumor-like growths on fish is unknown at present, although it may be fatal since very few larger fish are found with tumors. In flathead sole with tumors, growth decreased while mortality increased, and no evidence of tumor regression or sloughing was observed in the field or laboratory (Miller and Wellings, 1971). Field observations of Dover sole in southern California also showed no evidence of tumor sloughing (Mearns and Sherwood, 1974).

These rather variable data have been interpreted as suggesting that Dover sole may be particularly sensitive to tumor producing substances. Larval Dover sole are pelagic and wide ranging. If it is these pelagic young that are sensitive to tumor-producing substances, then no correlation between the location in which adults are captured and the presence of pollutants should be expected. Other explanations are possible, however.

Tumors on flatfish are not restricted to wastewater discharge areas but have been found in many areas far from such discharges. For example, tumor bearing Dover sole have been collected south of Cabo Colnett, Baja California, which is far from any urban areas (Sherwood and Mearns, 1976). Furthermore, the frequency of tumor occurrence in fish in southern California is at the lower end of the range reported for the Pacific (SCCWRP, 1973). Thus, it appears that tumor-like growths in flatfish are not related to wastewater discharges but are a widespread characteristic in juvenile populations (Mearns and Sherwood, 1974).

(b) LIP PAPILLOMAS. Lip papillomas (tumor-like sores) have been found on white croakers, tongue soles, basketweave cusk-eels, and Pacific sanddabs taken in Santa Monica Bay and the Los Angeles-Long Beach Harbor between 1956 and 1963, and such tumors have not been observed on fish from unpolluted areas. In May and June of 1956, 2.8 percent of the white croakers collected within 32 km (2 mi) of the HTP 1-mile outfall had lip papillomas (Young, 1964). Histological examination of the white croaker papillomas revealed they were not malignant; thus, they were probably caused by mechanical or chemical irritation or infection (Russel and Kotin, 1957).

Data for north and south San Pedro Bay, Palos Verdes, and Santa Monica Bay collected in 1970 through 1974 showed that the incidence of lip papillomas in white croakers ranged from 0.1 to 3.0 percent in south San Pedro Bay, 0.8 to 4.1 percent in north San Pedro Bay (in Los Angeles-Long Beach Harbor), 0.09 to 0.64 percent along Palos Verdes, and 0.17 to 0.3 percent in Santa Monica Bay (Mearns and Sherwood, in press). These papillomas occurred mainly in larger fish (greater than 100 mm in standard length) with few, if any, in small individuals, and this may be related to feeding habit since white croakers at a size of approximately 100 mm shift from plankton to benthos. Few surveys have been conducted in areas not influenced by major wastewater discharges. A hook-and-line survey off Camp Pendleton in 1971 collected 8 white croakers of which 5 had lip papillomas (Mearns, 26 August 1977). Only large fish were collected, however, so that no incidence rate could be calculated for the populations at this location. Camp Pendleton also appears to be the southern limit for the occurrence of lip papillomas. The highest incidence of this disease (4.1 percent) occurred in the Los Angeles-Long Beach Harbor which receives a considerable amount of industrial wastes while the incidence was less than 1 percent along Palos Verdes and in Santa Monica Bay.

Few surveys have been conducted in areas not influenced by major wastewater discharges. A hook-and-line survey off Camp Pendleton in 1971 collected 8 white croakers of which 5 had lip papillomas (Mearns, 26 August 1977). Only large fish were collected, however, so that no incidence rate could be calculated for the populations at this location. Camp Pendleton also appears to be the southern limit for the occurrence of lip papillomas.

Based on the existing data, Mearns and Sherwood (in press) have concluded that wastewater discharges are not related to the incidence of the disease.

(c) Fin Erosion Disease. Fin erosion disease has been found to occur in a number of fish species in the Southern California Bight, and there is reason to believe that fin erosion disease is caused by sewage effluent. Of the 121 species collected in trawls during 1969-1972, 35 species had at least one individual with eroded fins, and the most commonly affected species were Dover sole and white croaker (SCCWRP, 1973). The percentage of species with eroded fins was lowest off Port Hueneme (4 percent) and highest off Palos Verdes (45 percent). Fin erosion occurred in greater than 10 percent of the Dover sole and white croaker collected on the Palos Verdes shelf and at the Hyperion 7-mile sludge outfall in August through October 1971 (Figures III-C-44 and 45). Thirty-one species of fish collected in trawl samples during 1972-1973 had individuals with eroded fins (SCCWRP, 1974), and Dover sole was the most frequently afflicted species with rex sole second. The incidence of fin erosion in Dover sole was 39 percent off Palos Verdes, 1.7 percent in Santa Monica Bay, and 2.3 percent in San Pedro Bay (SCCWRP, 1975a). In the 1972 May-June trawls in Santa Monica Bay, fin erosion disease was observed in 9.1 percent of the slender sole, 9.5 percent of the greenblotched rockfish, and 1.3 percent of the Dover sole (Mearns et al., 1974). Most of the observations occurred in the vicinity of the HTP sludge outfall. At Dana Point during 1972-1974 sampling, 0.68 percent of the Dover sole had eroded fins while none were affected off Point Loma (1975) or Santa Catalina Island (1972-1974). The overall occurrence in Dover sole from 1972 to 1976 was 39 percent on the Palos Verdes shelf, 3.5 percent in Santa Monica Bay, 2.0 percent in south San Pedro Bay, and 0.67 percent at Dana Point (Mearns and Sherwood, in press).

The size range of Dover sole affected with fin erosion disease varies with location. On the Palos Verdes shelf both large and small fish were affected with a size range of 80 to 260 mm in May-June 1972 samples (Mearns and Sherwood, 1974) and 70 to 240 mm in September 1973 samples (Sherwood and Mearns, 1974). Apparently, fin erosion disease is still being initiated in fish less than 1 year of age (< 120 mm) on the shelf (SCCWRP, 1976). In Santa Monica Bay, however, the affected fish were only larger fish, ranging from 180 to 210 mm in the May-June 1972 samples and 120 to 200 mm in the September 1973 samples.

The occurrence of fin erosion only in larger fish in Santa Monica Bay could be explained by migration. Dover sole undergo seasonal migrations offshore in winter and onshore in summer, with the adults spawning in deep water during winter (SCCWRP, 1974 and 1976). Fin erosion could be initiated in young fish on the Palos Verdes shelf that migrate offshore in the winter and subsequently return onshore in Santa Monica Bay the following summer, perhaps as a result of changes in bottom currents (Mearns and Sherwood, 1974). Another explanation of the size difference in Dover sole with fin erosion from Santa Monica Bay and Palos Verdes is that initiation of the disease may require a longer period of exposure around the HTP outfalls where the sediments are not as heavily contaminated as on the Palos Verdes shelf. Thirteen months were required to induce fin erosion in the laboratory by exposing Dover sole to sediments from the Palos Verdes shelf (SCCWRP, 1976).

At least two types of fin erosion occur in the southern California species studied by SCCWRP (1973). The first is characterized by damage to fin tissue with no internal organ degradation. It occurs mainly in the dorsal and anal fins of flatfish (Figure III-C-46) or the pectoral fins of rockfish and other demersal species suggesting that locomotor behavior and sediment contact may be important factors in the development of the disease. The second type of fin erosion occurs as bloody lesions on the pectoral fins and upper part of the caudal fins in active free-swimming near-shore species, primarily the white coraker. The disease may be aggrevated by irritation caused by turbulence on the fin during swimming.

Laboratory studies of the first type of fin erosion in Dover sole have shown that the disease begins as a fraying of the fins followed by denuding of the fin ray tips (Mearns and Sherwood, 1974). Later, the long rays degenerate, and the fins thicken as a result of fibroplasia in the skin around the rays. Melanophores aggregate along the edge of the denuded areas forming a black line along the edge of the eroding fins (see Figure III-C-46). Histological stain techniques showed no evidence of bacterial, fungal, or protozoan infection.

Stress from biological accumulation of metals has been suggested as a cause of fin erosion disease in fish. The SCCWRP (1973) data, however, indicate that fin erosion, at least in Dover sole, is not correlated with the accumulation of any of the metals analyzed for in the liver tissue, except zinc, and that even with zinc the correlation is not strong. Fish from the vicinity of the JWPCP outfall, where metal concentrations in the sediments are high, have metal concentrations in their livers no higher than those at Santa Catalina Island where metal concentrations in the sediments are low.

Concentrations of a number of metals were also measured in muscle, gonad, liver, heart, brain, kidney, and gill arch tissue of Dover sole collected from the vicinity of the JWPCP outfall off Whites Point (SCCWRP, 1974). The levels of metals in "obviously diseased" and "apparently undiseased" sole were compared, and for two metals, lead and chromium, there were tissue concentration differences correlated with obvious disease symptoms. Lead and chromium were significantly more concentrated (95 percent confidence level) in the kidneys of diseased fish, and chromium was more concentrated in the liver (90 percent confidence level) as well. Chromium concentrations, however, were significantly lower in the gonads and hearts of diseased fish. These data, summarized in Table III-C-23, do not necessarily implicate lead and chromium as the factors causing fin erosion disease, but indicate only that alterations of metal uptake and fin erosion disease occur simultaneously. To determine whether metal uptake causes the disease or the converse, that the disease increases metal uptake, requires carefully controlled experiments that have not yet been done.

Table III-C-23. Chromium and lead concentrations in the tissues of diseased and apparently healthy Dover sole from the Palos Verdes shelf (SCCWRP, 1974).

	CHROMIUM (mg/dry kg)[1]	LEAD (mg/dry kg)[1]
GONADS		
Diseased	<0.2	-
Healthy	0.9	-
HEART		
Diseased	<0.2	-
Healthy	0.4	-
LIVER		-
Diseased	0.6	-
Healthy	0.2	-
KIDNEY		
Diseased	0.5	6.0
Healthy	0.2	3.1

[1] To obtain concentrations in mg/wet kg divide the reported values by 4.0.

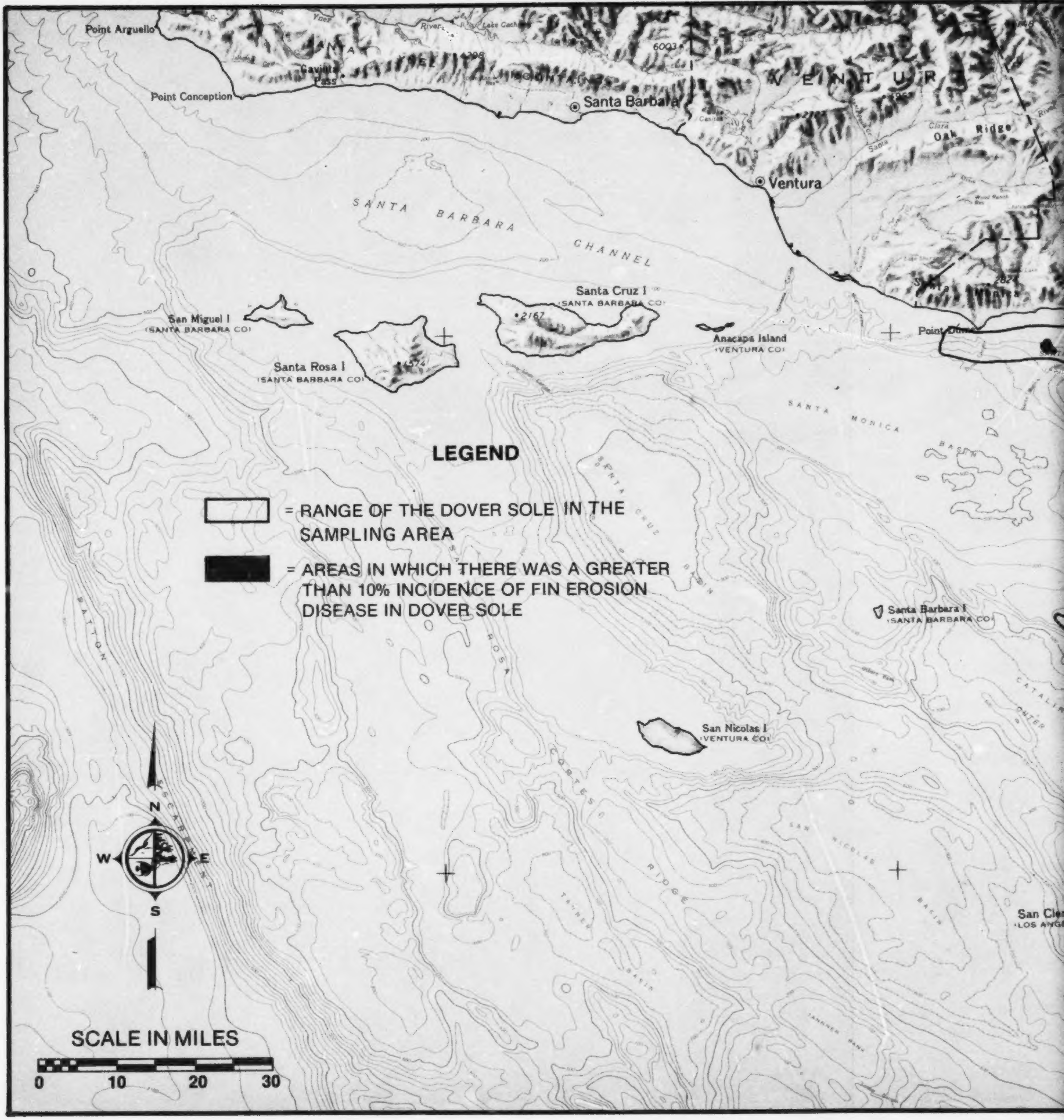
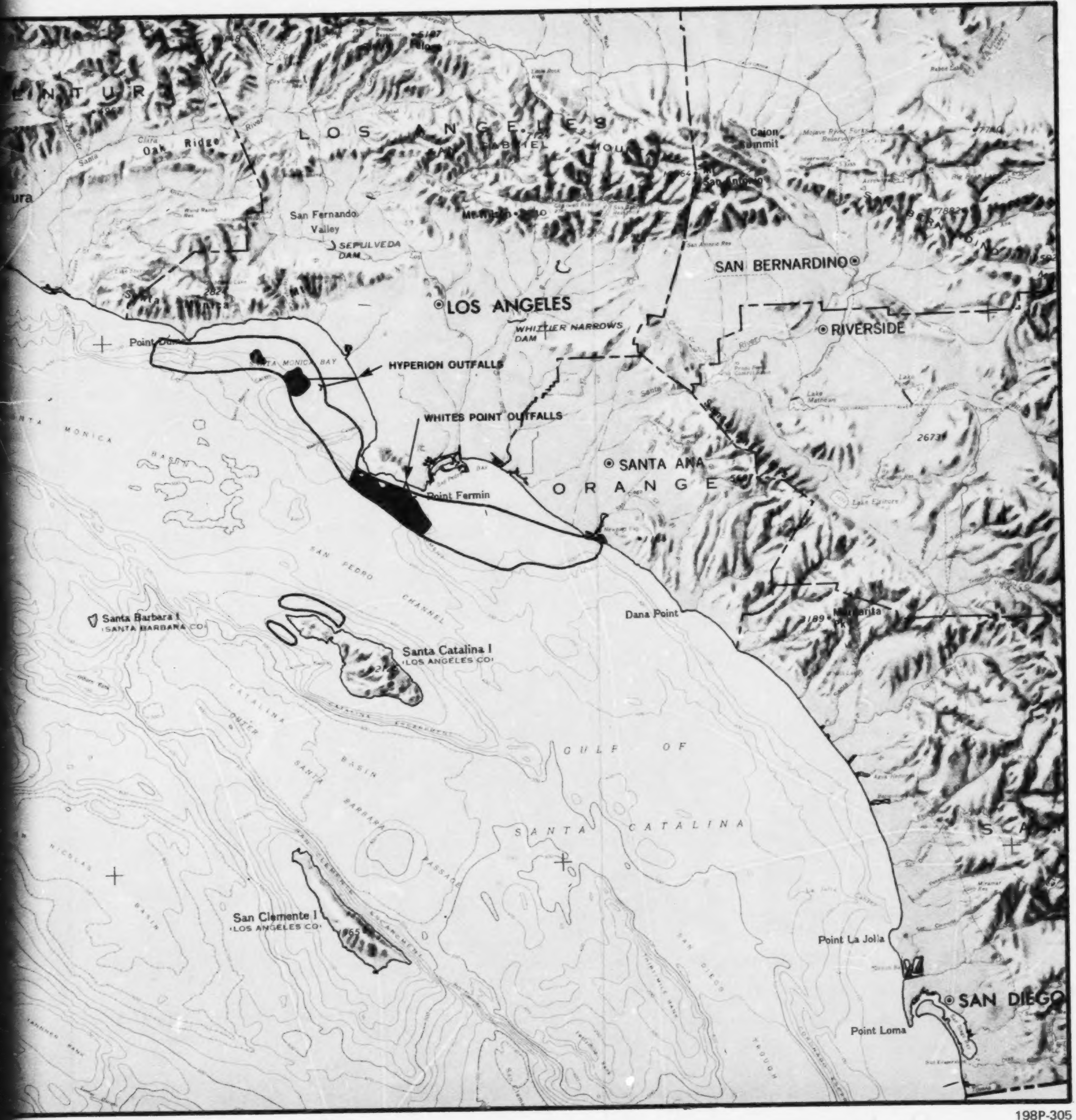

Point Arguello
Point Conception
Gaviota Pass
Santa Barbara
VENTURA
Oak Ridge
Ventura
SANTA BARBARA CHANNEL
Santa Cruz I
(SANTA BARBARA CO)
San Miguel I
(SANTA BARBARA CO)
Santa Rosa I
(SANTA BARBARA CO)
Anacapa Island
(VENTURA CO)
Point Dume
SANTA MONICA BASIN
LEGEND
= RANGE OF THE DOVER SOLE IN THE SAMPLING AREA
= AREAS IN WHICH THERE WAS A GREATER THAN 10% INCIDENCE OF FIN EROSION DISEASE IN DOVER SOLE
SANTA CRUZ BASIN
SANTA ROSA
PATTON ESCARPMENT
Santa Barbara I
(SANTA BARBARA CO)
San Nicolas I
(VENTURA CO)
CORTES RIDGE
TANNER BASIN
SAN NICOLAS BASIN
N
W
E
S
SCALE IN MILES
0
10
20
30

Figure III-C-44. The occurrence of fin erosion disease in Dover sole collected by trawl in August through October 1971. Depths are in fathoms (from SCCWRP, 1973).



LOS ANGELES
SAN BERNARDINO
RIVERSIDE
SANTA ANA
ORANGE
SAN DIEGO
Oak Ridge
San Fernando Valley
SEPULVEDA DAM
WHITTIER NARROWS DAM
Cajon Summit
Point Dume
SANTA MONICA BAY
HYPERION OUTFALLS
WHITES POINT OUTFALLS
Point Fermin
SANTA MONICA BASIN
SAN PEDRO CHANNEL
Dana Point
Santa Barbara I
(SANTA BARBARA CO)
Santa Catalina I
(LOS ANGELES CO)
San Clemente I
(LOS ANGELES CO)
CATALINA BASIN
OUTER SANTA BARBARA PASSAGE
GULF OF SANTA CATALINA
SAN NICOLAS BASIN
SAN DIEGO TROUGH
Point La Jolla
Point Loma
Margarita Pk
2673

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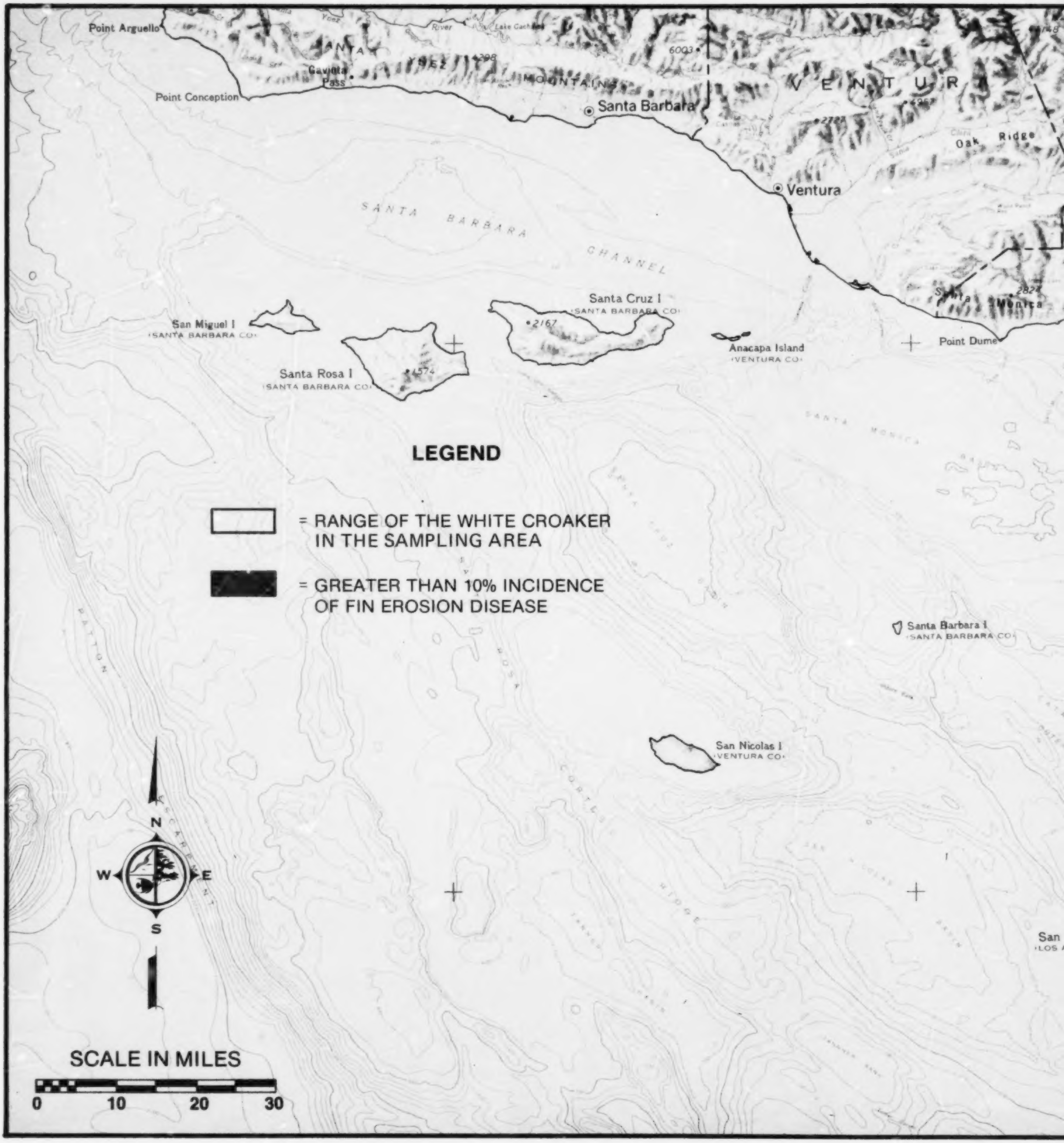
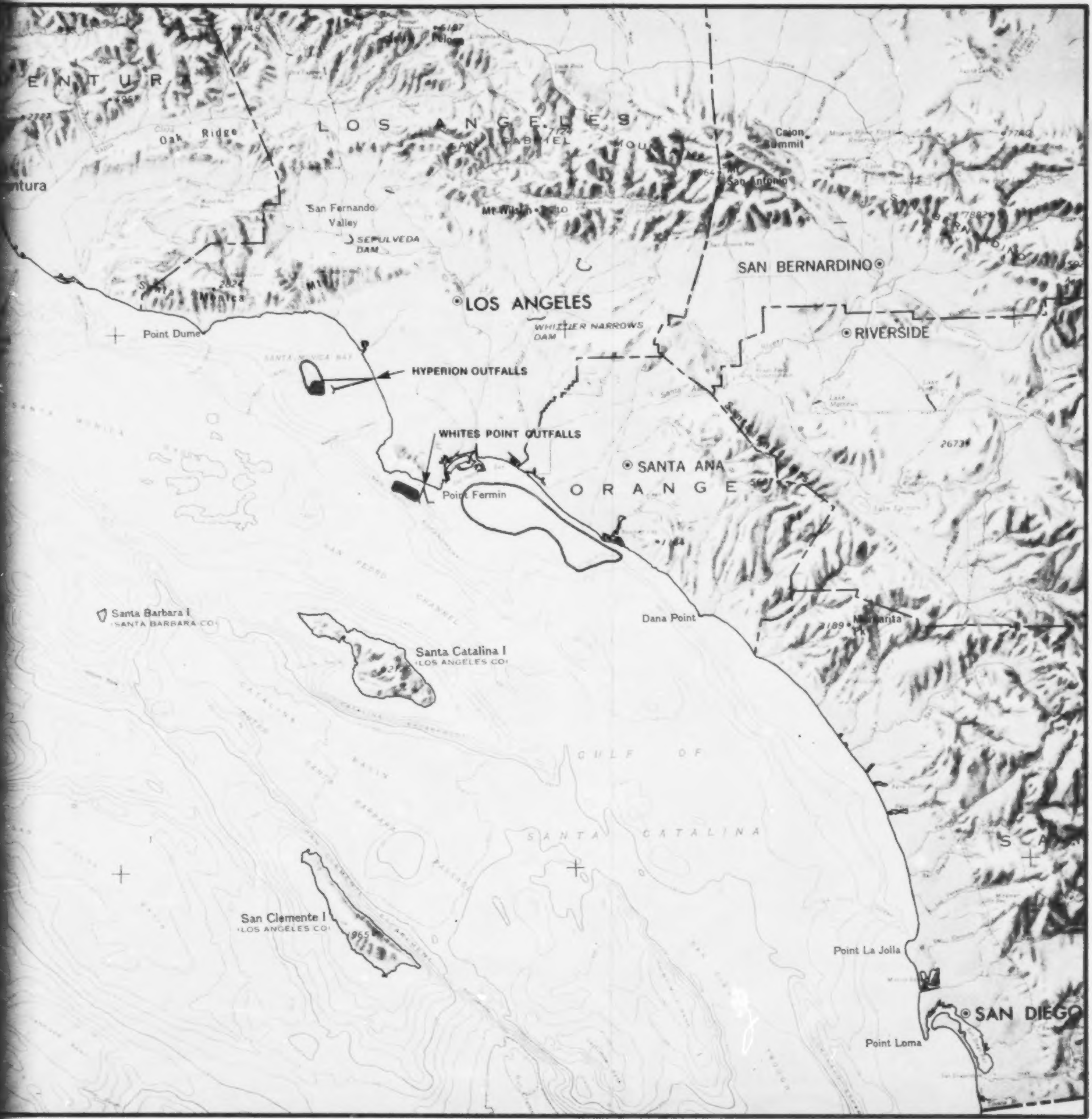

Point Arguello
Point Conception
Gaviota Pass
Santa Barbara
Ventura
Oak Ridge
SANTA BARBARA CHANNEL
San Miguel I
(SANTA BARBARA CO)
Santa Rosa I
(SANTA BARBARA CO)
Santa Cruz I
(SANTA BARBARA CO)
Anacapa Island
(VENTURA CO)
Point Dume
LEGEND
= RANGE OF THE WHITE CROAKER IN THE SAMPLING AREA
= GREATER THAN 10% INCIDENCE OF FIN EROSION DISEASE
Santa Barbara I
(SANTA BARBARA CO)
San Nicolas I
(VENTURA CO)
N
W
E
S
SCALE IN MILES
0
10
20
30

Figure III-C-45. The occurrence of fin erosion disease in white croaker collected by trawl in August through October 1971. Depths are in fathoms (from SCCWRP, 1973).



VENTURA
ntura
Oak Ridge
LOS ANGELES
SAN GABRIEL MOUNTAINS
Cajon Summit
Mt San Antonio
Mt Wilson
San Fernando Valley
SEPULVEDA DAM
Santa Monica Mts
SAN BERNARDINO
LOS ANGELES
WHITTIER NARROWS DAM
RIVERSIDE
Point Dume
SANTA MONICA BAY
HYPERION OUTFALLS
WHITES POINT OUTFALLS
SANTA ANA
ORANGE
Point Fermin
SAN PEDRO CHANNEL
Santa Barbara I
SANTA BARBARA CO
Santa Catalina I
LOS ANGELES CO
Dana Point
Margarita
GULF OF SANTA CATALINA
San Clemente I
LOS ANGELES CO
Point La Jolla
SAN DIEGO
Point Loma

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The relationship between concentrations of metals in sediments (high concentrations occurring near wastewater discharges) and uptake of metals by fish were discussed under Uptake, Toxicity, and Bioaccumulation of Sewage Constituents in Fish above.

Hydrogen sulfide in the sediment interstitial water has also been investigated as a causative agent in initiating fin erosion. The areal extent of free hydrogen sulfide in the interstitial water around the JWPCP outfall has decreased considerably in the past while fin erosion in young fish (less than 1 year old and 120 mm in length) has not declined (SCCWRP, 1976). Thus, hydrogen sulfide is apparently not involved in the initiation of fin erosion disease.

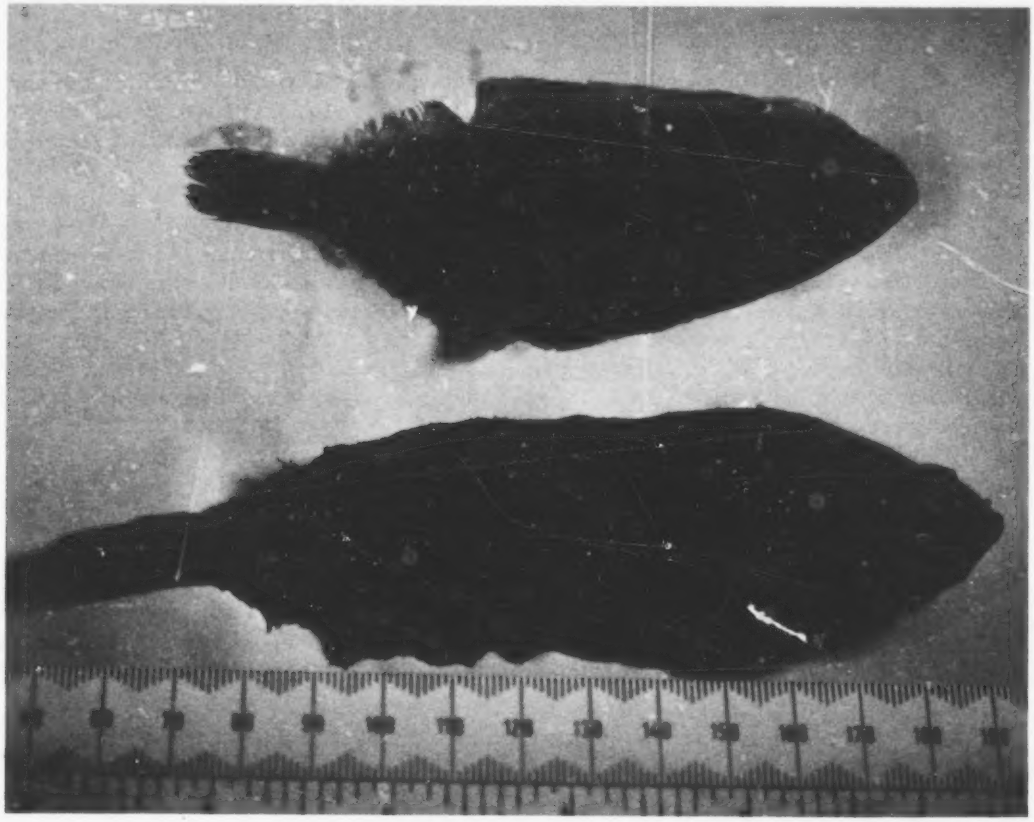

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Figure III-C-46. Fin erosion disease in Dover sole collected from the Palos Verdes Peninsula. The upper fish is normal and the lower one has eroded dorsal, anal, and caudal fins (photographs courtesy of SCCWRP).

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(d) Deformities and Asymmetry. The occurrence of bone deformities and asymmetry of bilateral anatomical characteristics may be other indicators of environmental stress. The California grunion, barred surfperch, and barred sand bass in the area from the Mexican border to the Long Beach Harbor have a higher incidence of gill raker deformities than those from Baja California. However, the barred surfperch also has a higher rate of deformities north of Point Conception where there are few sewage outfalls. Asymmetries in dentaries, lateral supraoccipital crests, scales above and below the lateral line, pored lateral line scales, pectoral fin rays, and total number of gill rakers were found to be greater in barred sand bass in southern California waters than off Baja California. The causative factors have not been identified.

g. Marine and Shore Birds.

(1) DISTRIBUTION AND ABUNDANCE OF MARINE AND SHORE BIRDS. Marine and shore birds are associated with ocean (pelagic, littoral, and bays) and shoreline (rocky shore-sea cliff, sandy beach, and Channel Islands) habitats in southern California. The number of species found in the ocean habitat are: pelagic - 33 species, littoral - 55 species, and bays - 46 species; and for the shoreline habitat are: rocky shore-sea cliff - 27 species, sandy beach - 35 species, and Channel Islands - 118 species plus 18 endemic subspecies. The species found in each habitat are listed in Appendix III.B. Four species are on the California Department of Fish and Game endangered species list. These are the California brown pelican, peregrine falcon, California least tern, and light-footed clapper rail. Salt marshes, estuaries, and tidal areas along the coast are utilized by marine as well as some freshwater and terrestrial birds. Appendix III.B lists the species found in these habitats as well.

The marine and shore birds found in southern California occur as permanent residents or as migratory visitors, and many breed on the Channel Islands. Population levels in all habitats fluctuate seasonally as the migratory species pass through or stop in the area. Aerial surveys of 2,784 km^2 in the Santa Barbara area in 1969 showed a population of 12,000 birds in February and March and 85,000 birds in April and May (Straughan, 1971).

The birds occurring in the vicinity of the Hyperion and Terminal Island Treatment Plants and their outfalls are expected to be the same as those listed in Appendix III.B for the habitat types characteristic of these areas.

(2) UPTAKE, TOXICITY, AND BIOACCUMULATION OF SEWAGE CONSTITUENTS IN BIRDS.

(a) Chlorinated Hydrocarbons in the Tissues of Birds. Marine birds concentrate DDT and PCB's in their body tissues, particularly those rich in lipids, from their food. Double-crested cormorants and white pelicans in South Dakota were reported to have concentrations of insecticides 250 and 280 times that in the fish they fed upon, while PCB concentrations were elevated 60 and 30 times (Greichus et al., 1973). In European cormorants the PCB concentrations are high and probably reach lethal levels in some individuals (Koeman et al., 1972). The concentrations are also high in the tissues of herons, although this species is not as susceptible to PCB toxicity as the cormorants.

Numerous experiments have been conducted to describe the accumulation of DDT and PCB's in bird tissues as a result of ingesting these substances and the subsequent effects on various body functions. Double-crested cormorants fed a mixture of DDT, DDD, and DDE at rates of 2, 5, and 10 mg/day for a 9 week period showed increased levels in the liver and brain at death or after a stress of half rations with a concomitant decrease in carcass levels (Greichus and Hannon, 1973). The concentration was 24 to 85 ppm in the brains of birds that had died and 0.4 to 29 ppm in the survivors. There was also a significant decrease in liver vitamin A concentration and liver and heart weights. In wild cormorants the carcass concentration of DDD was 1.0 ppm and of the three DDT metabolites combined was 10.6 ppm. White pelicans fed a daily dose of 100 mg of PCB or a mixture of DDT (20 mg), DDD (15 mg), and DDE (15 mg) in the first fish of each feeding for a period of 10 weeks showed a greater percentage retention of PCB in the brain, liver, carcass, and feathers than of the DDT complex (Figure III-C-47) (Greichus et al., 1975). Liver weight declined in relation (percent) to body weight in the DDT treated birds while the spleen weight increased in the PCB treated birds. The brain, heart, and kidney weights showed no significant changes for either treatment. The amount of vitamin A per gram of liver increased in the DDT treated pelicans as compared with the controls. Serum potassium and protein levels were significantly lowered in both groups while serum calcium and albumin fractions were reduced only in the PCB treated birds. The serum inorganic phosphorus, uric acid, magnesium, and globulin fractions were unaltered by either treatment (Greichus et al., 1975). PCB's also appear to affect the thyroid function in birds. Lesser blackbacked gulls fed 50, 100, 200, and 400 mg/kg Aroclor 1254 daily for 8 weeks exhibited increased thyroid weights, and the follicles were larger and filled with colloid (Jeffries and Parslow, 1972).

Chlorinated hydrocarbons can also affect bird populations by causing reproductive failure in the form of thin eggshells that break upon incubation and eggs that do not hatch. Both field and laboratory investigations have been performed to document these phenomena. Eggshell thinning apparently results from the inhibition of carbonic anhydrase and ATPase in the oviduct by DDT metabolites (Peakall, 1975), but the degree of thinning is species dependent with falcons the most susceptible and gallinaceous species the least (Cooke, 1973). Black ducks fed 10 ppm (dry weight) p,p'-DDE in their feed laid eggs with shells 22 percent thinner at the midline, 30 percent at the crown, and 33 percent at the apex. The

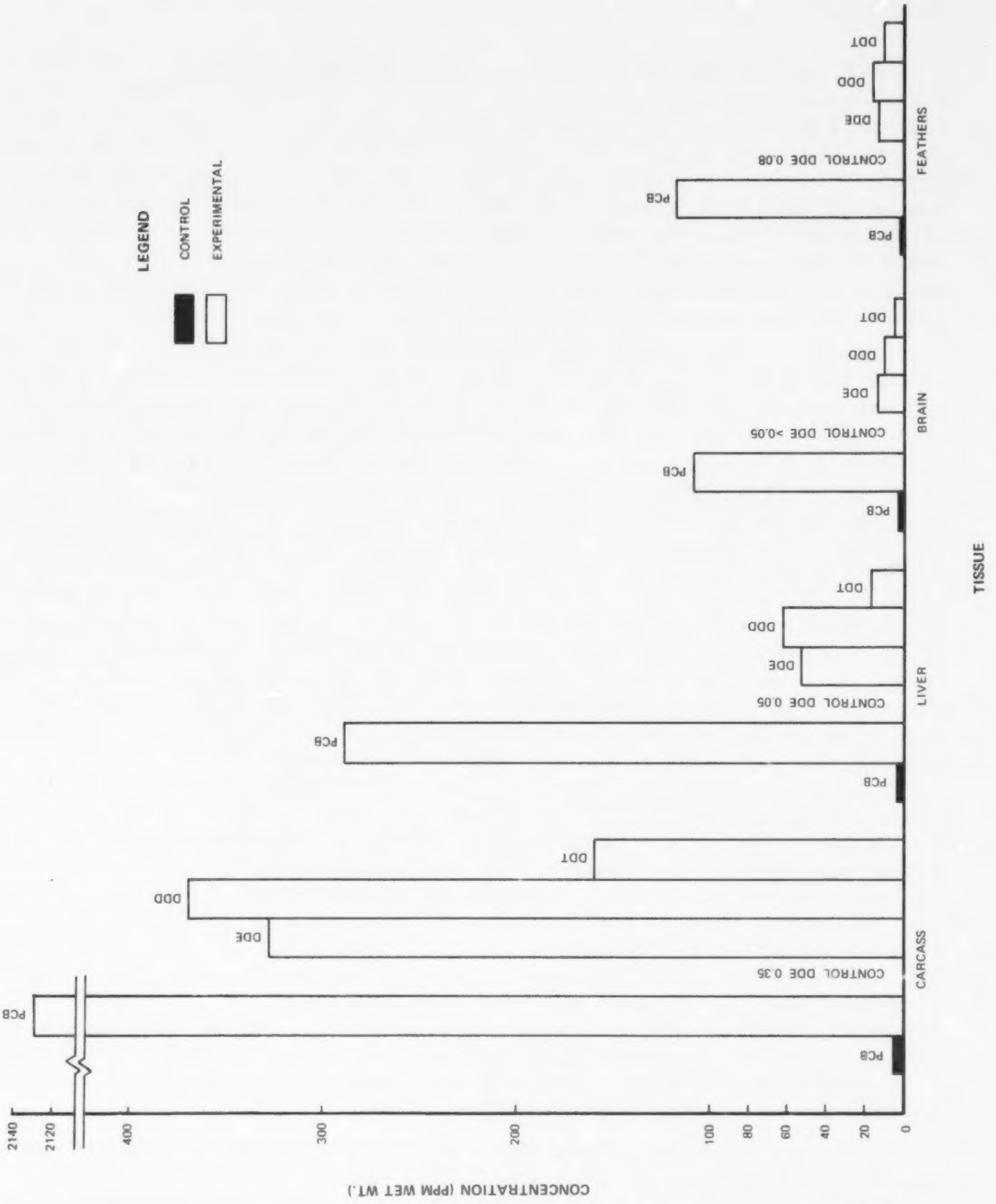

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Figure III-C-47. Concentration of DDT, DDD, DDE, and PCB in the tissues of white pelicans fed 100 mg/day of PCB or a mixture of 20 mg DDT, 15 mg DDD, and 15 mg DDE per day for a 10 week period (data from Greichus et al., 1975).

number of ducklings was reduced 80 percent, and the eggs contained 64.9 ppm (wet weight) DDE (Longcore and Samson, 1973). In ducks fed 250 ppm DDE for 10 days, for a total of approximately 0.5 g, the onset of eggshell thinning was rapid and irreversible. The shells were about 20 percent thinner than before DDE treatment, and recovery was less than one half after 27 weeks. The DDE concentration in the yolk after treatment was greater than 150 ppm and declined to about 90 ppm 27 weeks later (Peakall et al., 1975).

Brown pelicans transplanted from Florida to Louisiana produced 0.5 to 0.62 young/nest which was below the 1.2 to 1.5 young/nest necessary to maintain the population (Blus et al., 1975). The eggshell thickness averaged 0.517 mm in 1971, 0.486 mm in 1972, and 0.488 mm in 1973 while pre-1947 museum specimens averaged 0.554 mm. The eggs for 1971 through 1973 contained $\leq$ 0.31 μg/g (wet weight) p,p'-DDT, $\leq$ 0.98 μg/g dieldrin, and $\leq$ 6.4 μg/g PCB. DDE is apparently responsible for nest failure, although dieldrin also contributes (Blus et al., 1974). The maximum concentration of DDE in the eggs of successful nests was 2.37 μg/g and 8.48 μg/g in unsuccessful nests while the dieldrin concentrations were 0.54 μg/g and 0.99 μg/g. The residues of DDT, DDD, and PCB's were not significantly related to nest success.

In southern California, California brown pelican populations have declined in recent years as a result of pollution. This decline, however, is now slowing or possibly reversing (Anderson et al., 1975). Productivity in 1974 had increased significantly over that in 1971, although it was still approximately 30 percent too low to maintain a stable population. Eggshell thickness had also increased but was still significantly less than normal (pre 1943), and the DDE residues in intact eggs decreased significantly from 1969 to 1973-1974. At the same time, DDE levels in anchovies (the main food of pelicans) declined significantly (Anderson et al., 1975). Productivity, DDE residues, and eggshell thickness did not change significantly between 1974 and 1975 (Anderson et al., 1977).

(b) Mercury in The Tissues of Birds. Mercury is accumulated in birds via the food web. Approximately 20 mg/kg (ppm) in the muscle tissue can cause death of the bird and more than 0.66 mg/kg in eggs may reduce hatchability (Holden, 1972). Along the British coast pelagic species (kittiwakes, fulmars, and auks) contained less than 10 ppm (wet weight) in the liver tissue while the mussel eating eider contained 24 to 48 ppm and estuarine fish eating species (divers and red-breasted merganser) contained 9.1 to 122 ppm (Dale et al., 1973). The sublethal effects of chlorinated hydrocarbons and mercury are summarized in Table III-C-24.

Table III-C-24. Sublethal effects of toxicants on marine and aquatic birds.

CONSTITUENT	CONCENTRATION	SPECIES	EFFECT	REFERENCE
DDT + DDD + DDE	50 mg/day for 10 weeks	White Pelican	Decreased liver weight; increased liver vitamin A levels; lowered serum potassium and protein	Greichus et al., 1975
	2,5,and 10 mg/day for 9 weeks	Double Crested Cormorants	Decreased liver vitamin A and liver and heart weights	Greichus and Hannon, 1973
DDE	8.48 ppm in eggs	Brown Pelican Eggs	Nest failure	Blus et al., 1974
	250 ppm/day for 10 days	Duck	Eggshell thinning	Peahall et al., 1975
P,P'-DDE	10 ppm/day (dry weight)	Black Ducks	Eggshell thinning; reduced number of ducklings by 80 percent	Longcore and Samson, 1973
PCB	100 mg/day for 10 weeks	White Pelican	Increased liver and spleen weight; lowered serum potassium, calcium, protein and albumin fractions	Greichus et al., 1975
Aroclor 1254	50-400 mg/kg/day for 8 weeks	Lesser Black-Backed Gull	Increased thyroid weight and colloid in follicles	Jeffries and Parslow, 1972
Mercury	>0.66 mg/kg in eggs	Bird eggs	May decrease hatchability	Holden, 1972

h. Marine Mammals.

(1) DISTRIBUTION AND ABUNDANCE OF MARINE MAMMALS. The marine mammals of southern California, including those at the Channel Islands, consist of cetaceans (whales, porpoises, and dolphins), pinnipeds (seals and sea lions), and carnivores (sea otter). The species that may occur in the area are listed in Appendix III.B.

The southern California coast and adjacent islands are the most important breeding and hauling out grounds along the Pacific coast of the United States (except Alaska) for pinnipeds, and over twenty species of cetaceans frequent the area (BLM, 1975). The abundances of cetaceans in southern California waters vary widely. All of the Mysticeti (baleen whales) are transients in the area with only the California grey whale occurring frequently. Blue and humpback whales may occur off the southern California coast, but no confirmed sitings are recorded (BLM, 1975). The five most abundant Odontoceti (toothed whales, porpoises, and dolphins), from Point Conception to Ensenada in descending order of occurrence are the common dolphin, the Pacific white-sided dolphin, the northern right whale dolphin, the Pacific pilot whale, and the Dall porpoise and Pacific bottle-nose dolphin, together. All of the Mysticeti whales (Pacific right whale, California grey whale, sei whale, finback whale, blue whale, humpback whale) with the exception of the Minke whale, are listed on the Fish and Wildlife Service List of Endangered and Threatened Wildlife (U.S. Dept. Interior, 1974).

The most abundant pinnipeds are the California sea lion, the northern elephant seal, and the harbor seal. Aerial surveys of the Channel Islands in 1964 revealed 34,382 California sea lions, 2,158 northern elephant seals, and 645 harbor seals (Odell, 1971). The 1975 population estimate for the northern elephant seal is 6,000 individuals (BLM, 1975). Although the Stellar sea lion and northern fur seal are abundant in Alaska, only small colonies of approximately 75 to 800 occur on San Miguel Island (BLM, 1975).

The only carnivore to inhabit the area in the past has been the sea otter. It was exterminated from much of the California coast by fur hunters early in the 19th century; however, the population is making a comeback and now extends from Monterey to Morro Bay. If habitat conditions do not deteriorate, sea otters should again become established on the northern Channel Islands (BLM, 1975).

(2) UPTAKE, TOXICITY, AND BIOACCUMULATION OF SEWAGE CONSTITUENTS IN MARINE MAMMALS.

(a) Chlorinated Hydrocarbons in the Tissues of Marine Mammals. High levels of chlorinated hydrocarbons have been found in many marine mammals. Harp seals collected in the northwest Atlantic during 1969 to 1971 contained DDT and its metabolities (ΣDDT), dieldrin, and PCB's in their blubber (Frank et al., 1973). The concentrations of ΣDDT and PCB's increased with the age of the organisms up to maximum values of approximately 6.5 ppm and 4 to 5 ppm. Dieldrin concentrations were less than 5 percent of the ΣDDT concentrations, and all the substances were also concentrated in the muscle, liver, and brain tissues. Anas (1974) reported total DDT plus PCB concentrations in the blubber of harbor seals from the western Pacific. The mean (geometric) concentrations in blubber were 610.7 ppm (range = 380.7 to 2,350.0 ppm) at San Miguel Island, 862.7 ppm (range = 459.4 to 1,620.9 ppm) in Puget Sound, 62.5 ppm (range = 27.7 to 109.9 ppm) in the Columbia River, and 11.3 ppm (range = 6.8 to 27.8 ppm) for the Pribilof Island seals. In the blubber of pilot whales and long-snouted dolphins from the Lesser Antilles the concentration of DDT plus DDT metabolities ranged from 1.25 to 7.38 ppm, dieldrin from 0.007 to 0.04 ppm, and PCB's from 0.69 to 5.00 ppm (Gaskin et al., 1974). Beluga whales from the Mackenzie Delta, Northwest Territory, Canada, contained 0.01 ppm (wet weight) of p,p'-DDE and 0.02 ppm of p,p'-DDT in the muscle and liver while the blubber contained 2 to 4 ppm of p,p'-DDT and p,p'-DDE combined (Addison and Brodie, 1973).

The effects of DDT and PCB's on marine mammals may be to induce reproductive failure. California sea lions that had premature pups were found to have total DDT levels 8 times those in the blubber and 3.8 times those in the liver of females having normal deliveries (DeLong et al., 1973). PCB levels were similarly elevated, 6.6 and 4.4 times those in the blubber and liver of the normal delivery females.

(b) Heavy Metals in the Tissues of Marine Mammals. Mercury concentrations have been reported for the hair, blood, milk, and parasitic lice of northern fur seals from Saint Paul Island, Alaska (Kim et al., 1974). The concentration in the hair of nursing cows was 4.87 ppm while the blood contained 0.0995 ppm and the milk 0.0145 ppm. The parasitic lice from these seals contained from 0.2 to 0.6 ppm mercury. Mercury and cadmium concentrations in brain, liver, and kidney tissue of harbor and grey seals in Great Britain were reported by Heppleston and French (1973). The mercury concentration in the liver ranged from 4.9 to 113.0 ppm while the hair tissue contained 0.3 to 0.7 ppm. The concentration of mercury in the liver tissue increased with age of the organism while the concentration in the brain did not. Cadmium was concentrated in the kidneys with values of 5.3 to 22 ppm while the brain and liver tissues contained less than 1 ppm.

Marine mammals may be able to detoxify methylmercury through a chemical mechanism involving selenium (Koeman et al., 1975).

The California sea lion concentrates lead in the hard tissues (bone and teeth) more than in soft tissues (muscle and fat) as had been reported for humans (Braham, 1973). Dry weight concentrations were 8.7 to 34.2 ppm in hard tissues and 0.3 to 3.8 ppm in soft tissues.

Very little is known about the effects of metals on marine mammals; however, mercury, selenium, cadmium, and bromine apparently play some role in premature births of California sea lions (Martin et al., 1976). The average concentrations of these elements in liver and kidney tissues of adult females are shown in Table III-C-25. The concentration of each element is much higher in females having normal deliveries than those having premature deliveries. Furthermore, these elements show a general balance in the kidneys and liver of normal females while an imbalance occurs in the females having premature pups, particularly for Br and Cd. The atomic ratios were approximately 1 Hg: 1 Se: 1 Br in the normal mothers while the abnormal mothers had ratios of almost 1 Hg: 1Se with Br greatly depressed. These results suggest that a balance among elements is more important than the absolute concentration in the detoxification of Hg by Se (Martin et al., 1976).

i. Public Health Aspects of Wastewater Discharges.

In addition to the potential affects of bacteria and viruses discussed previously (Section III.C.a), several components of wastewater discharges may potentially impact human health indirectly. For example, several metals that are concentrated by fish and invertebrates are known to have toxic effects in humans. The metals of particular concern are mercury and cadmium, although lead may also affect humans. Mercury is a neurotoxin which, in sublethal concentrations, may cause loss of coordination, difficulty in speech, numbness of skin, and loss of peripheral vision (Kiyoura, 1964), while cadmium causes renal (kidney) tubular disfunction

Table III-C-25. Concentrations of Hg, Se, Br, and Cd in liver and kidney tissues of California sea lions having normal and premature births of pups. The values are geometric means of ten individuals each (Martin et al., 1976).

BIRTH	TISSUE	CONCENTRATION (μg/g DRY WEIGHT)			
		Hg	Se	Br	Cd
Normal	Liver	747	260	270	15.1
	Kidney	28.40	22.0	121	115
Premature	Liver	204	79	38	10.0
	Kidney	7.06	12.1	98	97

(Kerfoot and Jacobs, 1976) and bone brittleness (Waldichuk, 1974). Several instances of mercury poisoning in humans resulting from eating contaminated seafood have been reported with the most notable one occurring in Minamata, Japan. High concentrations of mercury have been found in several commercially important species, particularly swordfish and tuna, so that for consumer protection in the U.S., the Food and Drug Administration (FDA) has proposed an upper limit of 0.5 ppm (mg/wet kg) of mercury in seafood for human consumption.

Chlorinated hydrocarbons, such as DDT and PCBs, are a potenital threat to human health; therefore, the FDA has established a limit of 5 ppm (mg/wet kg) for edible fish and shellfish.

Another aspect of public health concern is that the FDA standards apply only to fish for sale to the public and not to the fish caught and eaten by the sport fisherman. Thus, people regularly catching and eating contaminated fish from the Los Angeles area, particularly near Palos Verdes and the Los Angeles Harbor, may be exposed to a considerable amount of mercury and DDT.

3. ADEQUACY OF THE EXISTING DATA FOR DESCRIBING THE IMPACTS OF THE HYPERION TREATMENT PLANT EFFLUENT AND SLUDGE ON THE MARINE ENVIRONMENT

To assess accurately the changes that have occurred in the existing environment it is essential to know not only the distribution, concentration, rate of accumulation (if indeed constituents of the effluent are accumulating), and ultimate fate of the effluent constituents, but also the biological effects of these constituents in the form and concentrations that they are encountered by organisms living in the ocean, and in the form and concentrations that they may eventually be encountered by the public (e.g., in sea food or in sludge washed up on beaches).

The data base consists of several kinds of studies that can be loosely grouped under the two headings: distribution and abundance (or concentration) of organisms and substances; and toxicity and pathogenicity of organisms and substances. Because wastewater and sludge have been released from HTP at the present location for a long time (since 1961), what might be viewed as a major experiment on the effects of sewage treatment plant effluent on the ocean has already been conducted.

Much has been learned from monitoring the discharge areas, and most of what is known is included in Section III-B and C. The data strongly suggest that detectable effects of the wastewater and sludge releases are confined to a relatively localized area offshore, and that outside the confines of Santa Monica Bay there are few if any direct impacts on humans and no detectable impacts on other organisms or on water quality. The key word here, however, is detectable. Most of the effluent from the 5-mile wastewater outfall is rapidly dispersed out of the vicinity of the outfall. Such dispersion results in substantial dilution to the point that the constituents of the effluent are difficult to detect but not necessarily to the point that they have no biological activity. Toxic substances from HTP can be accumulated by marine organisms and may be concentrated throughout the food web and eventually find their way to man. To attribute the concentration of a substance (mercury, for example) in fish in the open ocean to the original source of the contaminant is difficult at best, and usually impossible unless there is only one likely source. The wastewater from Hyperion Treatment Plant does not constitute a unique source of any toxic or nutrient compound; consequently, the effects of alterations of the effluent from HTP on the open ocean must be viewed as resulting in proportionately small incremental changes in the oceanic pollution load.

In the immediate vicinity of the 7-mile sludge outfall, however, there is evidence that the sludge particulates may be accumulated and trapped in the sediments, but there are difficulties in interpretation of and extrapolation from the existing data. These difficulties arise because of changes in intensity of sampling techniques over the years*; because of the virtual absence of data from the vicinity of the outfalls prior to their installation and activation; because gradual improvement in analytical chemistry and taxonomic knowledge indicates that some of the earlier work (and indeed some of the current work) may have been imprecise*; because the sampling grids used for many of the studies are very coarse or highly localized*; because the presence of the edge of the continental shelf and its discontinuity of topography and sediment characteristics at the end of the 7-mile outfall may have as strong an influence on the distribution of sediments and organisms as do the outfalls; and because the 7-mile sludge and 5-mile wastewater discharges are close together, and it is difficult to distinguish the effects of one from the other. Some of these difficulties are discussed below.

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*Items to be sampled or tested by HTP as well as sampling grids, frequency, and methods to be used are set by the EPA and the State in their NPDES permits; therefore, HTP could not comment as to the correct nature or adequacy of these until it had gained experience (Nagano, 18 November 1976).

a. Sampling Gear. Most of the samples of benthic organisms have been collected by HTP personnel in Santa Monica Bay utilizing a Shipek sampler. This sampler has been used by Los Angeles City and Los Angeles County Sanitation Districts because it was specified by the Regional Water Quality Control Board (Nagano, November 18, 1976). According to Word (June 17, 1976) the Shipek often inadequately samples benthic organisms because of its failure to penetrate deeply into the bottom sediments. Maximum volume of the Shipek is about 3 ℓ, and when full capacity is obtained, Word estimates that about 10 cm of benthic sediment has been penetrated. Most benthic sample volumes reported by HTP, however, have been less than 1.2 ℓ. Word has shown that a 1.28 ℓ Shipek volume is a result of a sediment penetration of only 5 cm. Many benthic infauna burrow to 10 cm and deeper; thus, much of the data collected by HTP on density of benthic organisms may not be comparable between stations and between years because of variable and inadequate sample volume.

The sampling gear utilized by different agencies for collecting zooplankton samples has varied between agencies. The only zooplankton data collected in Santa Monica Bay by HTP utilized vertical net hauls with a 0.3 m diameter net of 64 μ mesh. CalCOFI utilized a 1 meter diameter, 505 μ mesh net to sample near-shore zooplankton, and biovolume or biomass of zooplankton collected by the two sources are, therefore, not comparable.

b. Natural Variation in Distribution and Abundance of Organisms. Natural variations in the distribution and abundance of organisms, and variability between replicate grab samples may mask subtle changes resulting from the stress of sewage discharge constituents. The magnitude of sampling variation in general is often high, ranging from 20 to 300 percent of the actual numbers (McErlean et al., 1972). Thus, the effects of waste discharge or changeover from one type of discharge to another, often cannot be distinguished from this "background noise."

c. Taxonomy. Benthic organisms have been collected and identified from sediments in Santa Monica Bay by HTP personnel since 1971. The accuracy and comparability of these identifications over time, however, has been uncertain because of taxonomic ambiguities and synonymous nonmenclature (Word and Charwat, 1975). The accuracy of the early benthic identifications by HTP personnel were questionable because no standard taxonomic key for nearshore organisms existed. Under the leadership of SCCWRP, the City as well as biologists from other agencies and institutions have reached agreement on many identifications. Therefore, the HTP data for 1974, 1975, and 1976 are quite complete and significant interpretations should be achievable by analyzing these data (Nagano, November 18, 1976). These data, however, have not been analyzed yet. Biological effects of environmental stress may be observable only at the species level, and sewage-caused shifts in relative abundance and distribution of species may be missed if the sewage-intolerant species have not been distinguished taxonomically from closely related tolerant ones.

d. Laboratory Analytical Methods. Values of at least three sewage constituents (silver, mercury, and PCBs—Aroclor 1242 and total) have unexplained year-to-year and inter-laboratory variability. The concentrations of mercury in sediment samples collected by HTP personnel in Santa Monica Bay during 1970 and 1972 varied on a year-to-year basis by a factor of 44. Assuming that 1) discharge concentrations and loads remained approximately the same or decreased between 1970 and 1972, and 2) that box and Phleger core samples collected similar quality surface sediment samples, then "analytical methods used by the Hyperion Laboratory have produced a systematic increase in the observed concentration" (Eganhouse et al., 1976). For PCBs, Young et al., (1975) showed that in a split sample sent to three different laboratories, the values measured by SCCWRP and Bodega Marine Laboratory differed by no more than a factor of two, but that the values from both were 100 to 700 times as great as the values measured by HTP (Table III-C-26). As already noted, HTP laboratories were constrained by a number of factors including permit regulations which specified certain analytical methods and changing standards which necessitated some contract analyses and delays until sophisticated equipment could be obtained. At present, the Treatment Division laboratory is contrained from using certain analytical techniques known to provide more accurate results because the NPDES permit specifies something else and requests for change have been denied (Nagano, November 18, 1976).

Table III-C-26. PCB concentrations (μg/l) measured by three laboratories in split samples of Hyperion 7-mile outfall sludge collected prior to discharge, 5 to 11 June 1974 (from Young et al., 1975).

Laboratory	1242 PCB R-1	1242 PCB R-2	1242 PCB Avg	1254 PCB R-1	1254 PCB R-2	1254 PCB Avg	TOTAL PCB R-1	TOTAL PCB R-2	TOTAL PCB Avg
SCCWRP	27	24	26	11	14	12	38	38	38
Bodega Marine Laboratory	46	52	49	16	15	16	62	67	64
Hyperion Treatment Plant	<0.1	<0.1	<0.1	ND[1]	ND[1]	ND[1]	<0.1	<0.1	<0.1

[1] ND = not detectable

e. Laboratory Toxicity Studies (Bioassays). Laboratory bioassays conducted on representative marine biota to estimate impact of discharged waste constituents need to be examined carefully for relevance. Most literature reviews of chemical toxicity to organisms do not specify the background level of the test substance that the organisms were acclimated to before the bioassay. Organisms acclimated to higher background levels of a toxicant can usually tolerate higher test concentrations, thus, bioassays should be conducted by acclimating indigenous organisms to *in situ* background ocean concentrations before testing waste constituents.

f. Applicability of Laboratory Toxicity Studies to Analysis of Field Data. The concentrations of toxic substances in the sediments of Santa Monica Bay have been reported by most sources as mg/dry kg of sediment. The various sediments near the HTP outfalls in Santa Monica Bay contain substantially different amounts of interstitial water (water contained within the sediments but not chemically bound to them). For example, sludge or fine silt can be 80 percent water by volume, containing three times as much water as course sand or gravel. When toxicants are expressed as weight per dry weight of sediments the apparent concentration can be much greater than if it were expressed as weight per volume of wet sediment. It is not clear, however, whether either method of presenting sediment concentrations of toxicants accurately reflects either the toxicity or availability of toxicants to the benthic organisms. Most laboratory analyses of the toxicity of sediment constituents have been conducted by exposing organisms to known concentrations of substance dissolved in the surrounding water. The levels of toxic substances dissolved in the interstitial water, and in the water next to the sediments in Santa Monica Bay are not known. Substances attached to or combined in the sediments, but not dissolved in the interstitial water, may be inactive biologically, and for only a few substances (chlorinated hydrocarbons, Young 18 June 1976) is there known to be a proportional relationship between dry weight concentrations in the sediments and tissue concentrations in the benthic fauna. The tissues of Dover sole and other benthic fauna did not reflect the high concentrations of mercury present in the sediments from which they were collected (Eganhouse et al., 1976).

Most of the laboratory toxicity data available presents the concentration of toxicants in the surrounding water that causes sublethal or lethal effects during a timed exposure rather than the tissue concentration in the organisms that causes the toxic effects. Many organisms are capable of concentrating substances (bioaccumulation) to much higher levels than occur in their surroundings, and indeed may continue to do so until they die from the toxic effects. A critical kind of information needed to establish the potential toxicity of sewage constituents is the tissue concentrations that can be achieved by organisms from known concentrations in the sediments or water and the toxicity of these tissue concentrations. This kind of information is known for only a few species. For example, intracellular concentration of mercury by the dinoflagellate, *Isochrysis galbana*, reached very high levels before an overt physiological response was observed (Davies, 1974). Even as intracellular concentrations of mercury reached 1 g/l, *I. galbana* continued concentrating more mercury. Not until intracellular concentrations reached 2 g/l did growth stop and death ensue. The bay mussel, *Mytilus edulis*, concentrated copper from water containing less than 45 µg Cu/l (ppb) to tissue levels of 50 to 90 µg/g (ppm). This tissue level proved fatal to the mussels in 10 days (Adema et al., 1974).

Because of the difficulties involved in interpretation of the existing data, the conclusions reached in this analysis of impacts must be regarded as tentative and very much subject to alteration when new data become available.

D. summary

D. SUMMARY

1. PHYSICAL OCEANOGRAPHY

Physical oceanographic parameters, such as currents and upwelling are useful in determining the area of immediate impacts from wastewater discharges as well as the dilution and dispersion of effluent constituents throughout the Southern California Bight. The major currents in the Bight are the south flowing California Current which forms the western boundary of the Bight, the north flowing Southern California Countercurrent, and the California Undercurrent (Figures III-A-3 and 4). The prevailing direction of currents at the depth of most outfalls in the Southern California Bight is parallel to shore, and the average speed is 8-10 cm/sec. However, currents in Santa Monica Canyon (HTP discharges are near the head of this canyon) frequently move offshore.

Circulation patterns in Santa Monica Bay have not been studied in the detail necessary to accurately model the spatial and temporal distribution of the HTP effluent plumes. Thus, it is unknown whether oscillatory currents or stagnation occur, and if so, whether the frequency is such that sewage constituents could accumulate in the bay.

Upwelling is an important physical mechanism by which deeper water strata are mixed with surface waters. This vertical water movement periodically brings water of markedly different quality to the surface as a result of winds and horizontal water currents. Upwelling in the vicinity of the HTP outfalls may bring to the surface sewage constituents that would otherwise remain in deep water strata most of the time. These constituents (both nutrients and toxicants) would thus be directly available to surface organisms rather than indirectly or not at all.

Geological substrates are one of the many features of the Bay that influence the distribution and abundance of marine organisms, particularly benthos. Sediments in the Santa Monica and San Pedro Bay areas generally show a progressive decrease in grain size from sand nearshore to silt at the edge of the continental shelf. Other sediment types occur in some areas such as coarse sand at the head of Santa Monica Canyon, rock outcrop along Palos Verdes and Malibu, and fine organic deposits near the HTP and JWPCP outfalls. Artificial substrates such as breakwaters, piers, and submerged outfall pipes also provide solid substrates in the area. HTP wastewater and sludge discharges have modified the sediments in the immediate vicinity of the outfalls as described in the Chemical and Physical Inputs section.

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2. CHEMICAL AND PHYSICAL INPUTS

Many constituents found in municipal wastewater effluents also enter the Southern California Bight via natural geochemical cycles involving rock weathering, surface runoff, and other processes. Only when these constituents are artificially introduced in quantities large enough to potentially cause adverse environmental effects are they considered pollutants. Both natural and artificial inputs of chemical and physical substances occur continually throughout the Bight, and the major components of these inputs include water, nutrients, toxicant chemicals, sediments, dissolved gases, heat, bacteria, and viruses. In addition to many major industrial discharges into the waters of the Bight, 23 sewage treatment plants discharge continually, the second largest being the Hyperion Treatment Plant. Pollutants discharged from Terminal Island Treatment Plant into Los Angeles Harbor may also enter the Bight through currents and tidal flushing of the harbor. Municipal wastewater treatment plants discharge 74 percent of the total volume of all discharges into the Bight and more than 50 percent of the mass emissions of water quality parameters frequently measured (Figure III-B-1). Other sources of inputs into the Bight include aerial fallout, surface runoff, and ocean dumping by seagoing vessels.

Most (>98 percent) of the wastewater from the Hyperion Treatment Plant is released from the 5-mile outfall, located at a depth of 57 m (188 ft) on the continental shelf in Santa Monica Bay, and sludge is released through the 7-mile outfall at a depth of 98 m (320 ft) at the head of the Santa Monica Canyon which leads to a deep ocean basin. Figure III-B-5 shows an artist's conception of the location of these outfalls, and the distribution of substances released from them. The effluents from both outfalls rise because they are less dense than the surrounding seawater. As the effluents leave the 5-mile and 7-mile outfalls, they are rapidly diluted and dispersed by currents. The particulates suspended in these effluents settle out of the plume when their upward momentum stops, with the most dense particles settling closest to the outfalls. During the summer there is usually a well developed thermocline in Santa Monica Bay which prevents the transfer of water from the depth of the outfalls to the surface, so the effluent plumes are confined to, and dispersed within subsurface waters. During the winter the thermocline disappears and the plumes may reach the surface.

The spatial distribution of the HTP plumes has been monitored by several techniques, one of which is the monitoring of total coliform bacteria. This method, however, has several limitations, particularly the low survival rate of coliform bacteria in seawater. Existing data have shown no strong evidence that bacteria of sewage origin reach the shore, and it is likely that if constituents of the effluent do reach the shore, they do so in such low concentrations that they are either undetectable by conventional monitoring techniques, or are overshadowed by the same constituents reaching inshore waters by direct runoff or other land-based sources. Figure III-B-10 shows the distribution of coliform bacteria in Santa Monica Bay during the winter following a rainstorm in which shoreline sources appear to be contributing the nearshore bacteria. Another tentative method of measuring the plume distribution has involved tracing the distribution of suspended sediments by light transmission, but results from this study are not yet available.

The fate of the discharged constituents that cannot be accounted for in the bottom sediments has not been accurately determined. The metals (and chlorinated hydrocarbons) associated with the suspended solids may be transported out of the area by currents while some of the metals, particularly cadmium and nickel, may be released from the sludge particulates as they mix with seawater (Table III-B-10). Mobilization from the bottom sediments may also account for a small amount of the loss. Organic material may be lost via transport out of the area as suspended solids or through decomposition by bacteria and other benthic organisms.

California bay mussels apparently are very good indicators of concentrations of chlorinated hydrocarbons too low to be measured by standard analytical methods. A single study using those mussels suspended in the water about 1 km from the 7-mile outfall showed that chlorinated hydrocarbons (DDT and PCBs) were present in concentrations high enough to be accumulated by the mussels. These toxic substances probably come either from effluent currently being discharged or from sediments previously deposited through the outfalls. This result suggests that other toxic substances of sewage origin may be present in the water near the outfall in concentrations too low to be directly toxic to any organism group, but high enough to be concentrated biologically.

Sludge from the HTP 7-mile outfall consists mainly of water ($\sim$ 99 percent dissolved solids (0.09 percent by weight), and fine particulates (0.75 percent by weight) in the form of settleable and suspended solids. Most of the metals (greater than 90 percent) discharged in the sludge are associated with the particulates. Core sample surveys in the vicinity of the 7-mile outfall indicate that discharged sludge has accumulated to a depth of 30 cm over an area of approximately 4 km^2, and grab samples of the bottom sediments indicate that the highest concentrations of sludge constituents rapidly decline with distance from the outfall, as does the depth of the sludge. Sediment trap studies have shown that currents may transfer much of the sludge away from the outfall and into the Southern California Bight where it is dispersed, but accurate mass balance studies to determine the percentage of sludge remaining near the outfalls have not been made. Whatever their fate, the sludge particulates do not appear to have moved shoreward as a discrete mass in the past. If currents were to cause the sludge to move shoreward in the future, it probably would be suspended and dispersed because of its finely divided physical structure mixing in with other bottom sediments. The considerable wave action in Santa Monica Bay would contribute to this mixing and dispersion.

The sediments in the immediate vicinity of the 7-mile outfall have been altered substantially by the past sludge discharges. The presence of a sulfide smell, noted subjectively at the time of sampling (Figure III-B-13), in the sludge sediments suggests that some areas of these sediments remain chemically reduced and anaerobic since sulfides are oxidized rapidly in the presence of oxygen. Volatile solids (an index of organic content) accumulate near the end of the 7-mile outfall (Figures III-B-14 and 18) as do sulfides, arsenic, cyanide, COD, and BOD (Figures III-B-16 and 17). Higher than background concentrations of heavy metals and chlorinated hydrocarbons also occurred in the vicinity of the 7-mile outfall (Figures III-B-14 and 19 through 28). Only phenols and chlorinated hydrocarbons showed a definite relationship to the 5-mile outfall (Figures III-B-16 and 19). It has been estimated that as much as 40 percent of the volatile solids and 70 percent of the metals discharged in the sludge may still remain in the sediments surrounding the outfall, but definitive studies have yet to be made.

3. BIOLOGICAL ENVIRONMENT

The major groups of organisms inhabiting the Southern Caifornia Bight that might be affected (adversely or beneficially) by wastewater discharges from the City of Los Angeles include phytoplankton, zooplankton, benthos, nektonic invertebrates, fish, marine mammals, and birds. The Southern California Bight contains many habitats which support numerous biological assemblages. The area primarily impacted by the HTP discharges is that portion of Santa Monica Bay within a few kilometers of the outfalls and Santa Monica Canyon. The regional effects may reach throughout the Bight and even into the entire Pacific Ocean.

a. Distribution and Abundance of Organisms in the Vicinity of Hyperion Treatment Plant Outfalls.

Bacteria and Viruses. Bacteria and viruses are natural components of the marine ecosystem, and sediments normally contain one to two orders of magnitude more bacteria than the water column for equivalent volumes. Wastewater discharges contain many bacteria and viruses of which some are pathogenic and thus constitute a potential public health hazard. Humans may be exposed to these organisms through recreational use of contaminated water or by ingesting contaminated seafood. The drug resistance (R factor) found naturally in enterobacteria is also of public health concern since it may be transmitted from sewage to humans by the ingestion of contaminated water or poorly cooked seafood.

Survival rates of bacteria and viruses in seawater are generally unknown but are probably species-specific. Coliform bacteria, in general, apparently survive for less than two weeks, and sunlight kills them within 3 meters of the surface. Predation by other marine microorganisms also influences bacterial survival rates. As discussed in Section III.B, bacteria from the HTP 5- and 7-mile effluents apparently seldom reach the shoreline, and there are no known epidermological studies.

Phytoplankton. Phytoplankton, along with the benthic algae and other plants, constitute the base of the marine food web. Phytoplankton generally react to influences such as nutrients and toxicants with variations in rates of growth and reproduction. These reactions become evident rapidly since phytoplankton reproduce relatively quickly in comparison to higher organisms. The effect of nutrients reaching surface waters from upwelling and/or sewage effluents can cause almost immediate blooms of diatoms, which may be followed upon cessation of nutrient input by similar population explosions of dinoflagellates, a group to which red tide algae belong. Direct or indirect correlation of toxic red tide blooms to sewage discharge, however, is difficult to establish because diatoms usually out-compete dinoflagellates in the vicinity of a continuous nutrient input. Thus, a certain sequence of events generally occurs before a red tide bloom: a) initiation of nutrients input, b) diatom bloom, c) cessation of nutrient input, and d) diatom population die-away. Phytoplankton production near the HTP outfalls has been shown to be elevated in surface waters at certain times of the year but not at others, indicating intermittent periods of eutrophication from periodically surfacing effluent plumes.

Zooplankton. Zooplankton comprise a wide variety of first level consumers that are represented by life stages from almost every major phyla of marine animals. These organisms are usually quite small and, like phytoplankton, drift relatively helplessly with water currents. Most zooplankton species are distributed rather evenly throughout most of the Bight, although inshore diversity generally exceeds that of offshore regions. Zooplankton blooms usually occur subsequent to or simultaneously with phytoplankton blooms, and increases in zooplankton standing crop usually result near areas of upwelling.

Benthos. Benthic algae (an example of which is kelp) occur along most of the southern California coast; however, because of specific habitat requirements they grow abundantly in some places and not at all in others.

Included among these requirements are suitable substrate, temperature, light, sedimentation, and lack of predation. Lack of suitable substrate is probably the factor most limiting to kelp growth in Santa Monica Bay. Little kelp exists in the Bay, either presently or historically, that might be influenced directly by either the 5- or 7-mile HTP discharges. Kelp beds located elsewhere in the Southern California Bight, for example off Palos Verdes, are postulated to have been damaged by sewage enhanced populations of sea urchins. It remains possible that the influence of HTP discharges may reach these beds.

Benthic invertebrates are probably the most studied of all Santa Monica Bay biota, and much information is available on distribution and abundances of these organisms near the HTP outfalls. The major communities that have been mapped along the southern California coast are dominated by a few representative invertebrates. Typical biota found all along the coast is well represented in the Bay although only two major communities dominate the area: the brittle star, *Amphiodia,* and Polychaete worm/ button clam, *Nothria/Tellina* communities. A general increase in total benthic biomass occurs near both HTP outfalls (Figures II-C-15, 25 and 26) except directly adjacent to the mouth of the 7-mile sludge outfall. Variations in organism distribution and abundance related to the HTP outfalls can usually be discerned only at the species level, however. Certain species show definite affinity to the outfalls (such as the polychaete worm, *Capitella capitata*), while others (such as the clam, *Parvilucina tenuisculpta*) appear to avoid at least the immediate area around the sludge outfall. Sea anemones, sand stars, sea cucumbers, and soft corals were observed to be the dominant benthic organisms residing on or near the HTP outfall pipes (see Figures III-C-9 through 14 and Table III-C-7).

Certain benthos taken either commercially or privately may provide important sources of seafood, fish bait, and related products. These biota include the spiny lobster, abalone, mussels, kelp, rock crabs, sea urchins, scallops, clams, and miscellaneous small shellfish. Several of these biota can occur within the influence of the HTP outfalls and are subject to the nutrient benefits and toxicant liabilities existing there.

Nektonic Invertebrates. Few studies have been conducted on the distribution and abundance of nektonic invertebrates in the Southern California Bight, and there are no site-specific data for the species in the vicinity of the HTP outfalls. Videotape surveys of the outfall pipes by SCCWRP, however, have shown dense aggregations of rapidly moving objects that may be shrimp-like crustaceans around the 5-mile outfall diffusers, although the resolution of the equipment was not sufficient to identify these objects. A moderately underutilized commercial fishery exists in the Bight for several species of nektonic invertebrates with market squid (*Loligo opalecens*) the most valuable in terms of weight landed and monetary return. Most are processed as wetfish although some are sold as live bait. The other species collected are used mainly as bait.

Fish. The Southern California Bight has a wide variety of habitat types, ranging from semi-enclosed bays to deep basins, which support diverse fish populations; at least 481 species are known to occur from Point Conception to the Mexican border. In Santa Monica Bay, the species that occurred most frequently in 1969-72 trawl surveys were the speckled sanddab and plainfin midshipman. Trawls conducted from 1958 through 1963 showed that the mean number of species and the median number of fish per trawl were apparently lower near the HTP outfalls than in control areas at the same depth. Further surveys in 1972 showed speckled sanddab and yellowchin sculpin to be the most abundant species near the 5-mile outfall. Photographs of the outfall pipes were taken from a two-man submarine in 1974, and rockfish represented more than 50 percent of the fish species observed.

The Bight supports a large commercial and recreational fishery, and the Port of Los Angeles reports the largest commercial landings (including out-of-state tuna catches) in the Bight (Figure III-C-35). Abundances of the species present have changed over time, probably largely as a result of fishing pressure although natural population fluctuations, pollution, and habitat destruction have undoubtedly had some effects. The recreational fishery in the Bight consists of hook-and-line fishing from party boats, private boats, piers and jetties, and the shoreline. Skin and SCUBA diving have also developed into a substantial fishing pressure in recent years. The estimated net economic value of the sport fishery for 1970 was approximately equal to or greater than that of the commercial fishery.

Santa Monica Bay is closed to commercial fishing, except for sportfish bait using small nets, and commercial landings are minor compared to other ports in the Bight. In 1972, boats out of Santa Monica Bay accounted for one-quarter of the recreational party boat catch reported for the Bight, and three-quarters of this catch was rockfish. This does not mean, however, that all of the catch was taken in the Bay.

The HTP effluents contain nutrient compounds in the form of inorganic nitrogen and phosphate, organic nitrogen, and organic carbon which could potentially augment fish productivity in the Bight via the food web. Calculations of the hypothetical increases in the commercial fishery have been made in this report, but the possible influence on productivity at each trophic level of toxic substances also released in the effluents has not been considered in these calculations because there are insufficient data to do so. The estimates of increased productivity in this report, therefore, may considerably overestimate the biomass production from sewage derived nutrients.

Figure III-C-38 summarizes the calculations for nitrogen. If all of the nitrogen (organic and inorganic) released from HTP were incorporated into fish in an efficient biological manner then there could be an increase of 18,000 metric tons per year of low trophic level fish, or 1,800 metric tons per year of piscivorous (top trophic level) fish. In comparison, the total commercial fish catch from the Southern California Bight brought into Los Angeles Harbor in 1972 was 92,897 metric tons. Thus, the maximum possible benefit that the nutrients from HTP could be having on the commercial fishery would be to support 19 percent of the annual commercial catch brought into Los Angeles Harbor, assuming that all of the effluent nutrients were channelled directly into the food web supporting low trophic level fish which were then caught commercially. The potential effect on top trophic level fish would be one-tenth as great. The commercial catch, however, is approximately half low trophic level and half top trophic level fish so that the beneficial effects of HTP nutrients would undoubtedly constitute much less than 19 percent of the commercial catch. Furthermore, all of the fish produced may not be of commercial (or recreational) value, thus reducing this percentage by some unknown factor.

The assumptions used and the reliability of the estimates are discussed in the report. It should be noted, however, that some of the assumptions may be off by as much as two orders of magnitude. Other sources of error are (1) that most of the nitrogen may be transported to deep ocean basins where it is deposited in the sediments or to areas where it recycles in food webs that do not include fish (or fish of commercial value) and (2) that much of the nitrogen may be transported out of the Los Angeles area or even out of the Bight. In the latter case, the calculated increases in the fishery should be compared to some larger catch, such as the West Coast or the Pacific Ocean catch.

Similar calculations of the potential increase in the commercial fishery that could accrue from the HTP discharges of organic carbon resulted in a maximum productivity of 290 metric tons of low trophic level or 29 metric tons of top trophic level fish (Figure III-C-39). This represents only 0.3 or 0.03 percent of the 1972 commercial fish catch landed in Los Angeles Harbor. As with the calculations for nitrogen, these values probably overestimate the actual productivity potential.

These types of calculations serve to indicate that, even under optimal conditions, the potential increases in the commercial fishery that could result from the nutrients discharged by HTP are small. In reality, the effects are probably confounded by the influences of toxicants, advection, and alternate nutrient pathways, and there is insufficient evidence to conclude that the past and present HTP discharges have increased the commercial (or recreational) fishery in the Los Angeles area.

Marine and Shore Birds. May species of marine and shore birds occur in the Southern California Bight either as permanent residents or migrants. Four of these species are on the California Department of Fish and Game endangered species list: California brown pelican, peregrine falcon, California least tern, and light-footed clapper rail. The species expected to be found in the vicinity of HTP and TITP are the same as those listed in Appendix III.B for the habitat types characteristic of these areas.

Marine Mammals. Many species of marine mammals reside in or pass through the Southern California Bight. The Channel Islands and the coast of southern California are the most important breeding and hauling out grounds for pinnipeds (seals and sea lions) along the Pacific coast of the United States, excluding Alaska, and more than 20 species of cetaceans (whales, porpoises, and dolphins) occur in the Bight. California grey whales are the most frequently occurring Mysticeti (balleen whales) while the most abundant Odontoceti (toothed whales) are the common dolphin, Pacific white-sided dolphin, northern right whale dolphin, Pacific pilot whale, Dall porpoise, and Pacific bottle-nose dolphin. All of the Mysticeti, except the Minke whale, are on the Fish and Wildlife List of Endangered and Threatened Wildlife. The most abundant pinnipeds in the area are the California sea lion, northern elephant seal, and harbor seal.

b. Uptake and Toxicity of Sewage Constituents in Marine Organisms.

Phytoplankton. Phytoplankton accumulate sewage-derived toxicants until they die, are eaten, or move out of the influence of toxic inputs. For example, based on laboratory bioassay information presented in Table III-C-2, zinc, copper, and cadmium at the concentrations present in the undiluted HTP effluent may be lethal or physiologically damaging to certain phytoplankton. Furthermore, phytoplankton cultures exposed to diluted HTP sewage were shown to reproduce at levels below their potential, and toxicants present in the sewage may have caused this inhibition. Thus, phytoplankton growth in the vicinity of the HTP outfalls may not reach its full potential when nutrient enrichment reaches the surface because of toxic constituents in the sewage.

Zooplankton. Zooplankton can also accumulate high tissue levels of toxicants, either through their food or by absorbing materials directly from seawater. Effluent constituents such as DDT, silver, zinc, copper, and iron may have lethal or sublethal effects on certain life stages of marine animals existing as zooplankton if these organisms encounter undiluted HTP effluent (Table III-C-2). Zooplankton (sampled in combination with phytoplankton) however, showed minimal increases over background levels in surface waters near the present HTP outfalls (Figure III-C-5), indicating that toxicants may not measureably decrease zooplankton production near the HTP outfalls.

Benthos. Bioaccumulation of certain toxicants by benthos near the HTP outfalls was examined for 1972 (Figures III-C-31 and 32). These data show that accumulations of some metals were related to the outfalls but the data are suspect because the metals may have been in sediments ingested by the organisms rather than in their tissues. Mussels suspended near the outfalls in 1976 (Figures III-C-28 and 29) did, however, accumulate DDT and PCB in their tissues from nearby sediments or effluents. Some diseases and abnormalities have been observed in benthos, but none have been shown to be directly related to discharges from the HTP outfalls.

Nektonic Invertebrates. Literature data on the uptake of metals by nektonic invertebrates indicate that metals may be adsorbed to the exoskeleton or absorbed internally. Based on laboratory bioassay data for various species of shrimp, it appears that the concentrations of sewage constituents in the undiluted 5-mile effluent are below the lethal and sublethal levels for all of the organisms tested. For the 7-mile effluent, however, copper and iron were within the lethal and sublethal range for European brown shrimp, and DDT exceeded the lethal level for sand shrimp. Since tolerance to toxicants is species-specific, these data cannot be extrapolated with confidence to species found in the vicinity of the HTP outfalls. Thus, the present effects of sewage constituents (both nutrients and toxicants) released by the HTP outfall on nektonic invertebrates, particularly those noted in the videotape surveys, cannot be predicted at this time.

Fish. Studies conducted along the coast of southern California have shown that chlorinated hydrocarbons occur in significantly higher concentrations in the tissues (particularly the liver) of fish collected near wastewater outfalls than in other areas. Several species of fish collected along the Palos Verdes peninsula have exceeded the FDA standard of 5 ppm (mg/wet kg) DDT in edible tissue. At the HTP 5-mile outfall, yellowchin sculpin had greatly elevated TICH in muscle and liver tissues compared to the same species at a control site (Figure III-C-40). Data for other species collected in the same study were inconclusive. Fish apparently accumulate metals in various body tissues also, but studies conducted at both the JWPCP (Whites Point) and HTP outfalls have not shown significantly higher concentrations in fish from the outfall areas as compared to those in nondischarge areas. The one exception to this is chromium which is apparently concentrated in the liver of Dover sole collected near the JWPCP outfalls.

The direct toxicity of various constituents in the HTP effluent to fish in the vicinity of the outfalls is unknown. Laboratory bioassay data are not very applicable for determining direct toxicity since few studies have been conducted on the species known to occur near the outfalls and toxicity is very species-specific. The indirect effects of toxicant discharges on fish through bioaccumulation are also unknown. Thus, even though fish may accumulate chlorinated hydrocarbons, the impacts of the HTP discharges of these substances on fish populations in the Bight have not been determined. The effects of other wastewater toxicants, such as heavy metals, phenols, and ammonia, are also unknown. Even after an effect has been recognized, it is very difficult to determine the source of the pollutant causing an effect since fish are very mobile as are many of their food organisms.

Several diseases normally occur in fish, and the incidence of these diseases may be enhanced by stresses imposed by sewage discharges. The diseases of particular concern in southern California are fin erosion disease and tumors. Both occur in several species of fish with flatfish species the most frequently afflicted. Tumor-like growths have been found most frequently on small Dover sole in the Bight, and there appears to be no correlation of these growths to wastewater discharges. Tumors in flatfish are evidently a widespread characteristic of juvenile populations.

Dover sole and white croaker are the species most commonly affected by fin erosion disease, and the highest incidence is near sewage outfalls, particularly those of JWPCP (Figure III-C-44). Histological examination of diseased fish tissues has shown no evidence of bacterial, fungal, or protozoan infection, and stresses from heavy metal uptake or hydrogen sulfide in the sediments have been suggested as possible causes of the disease. Studies performed to date have not shown a cause and effect relationship between heavy metals and the disease, but only that alterations in metal uptake and fin erosion occur simultaneously. Field studies at the JWPCP outfalls have shown that hydrogen sulfide is probably not involved. The causes of both diseases are presently undetermined.

Lip papillomas (tumor-like sores) are another disease that has been found on several species of fish in southern California since 1956. The highest incidence of this disease in white croaker (4.1 percent) occurred in the Los Angeles-Long Beach Harbor which is polluted by numerous discharges including industrial sources and Terminal Island Treatment Plant. The incidence along Palos Verdes and in Santa Monica Bay was less than 1 percent in 1970 through 1974, and the only recorded incidence in areas not influenced by major wastewater discharges was off Camp Pendleton in 1971. In white croaker, the disease occurs almost exclusively in fish longer than 100 mm (SL), and the papillomas are not malignant.

Marine and Shore Birds. Marine and shore birds concentrate chlorinated hydrocarbons (DDT and PCBs) in their body tissues to levels as high as 280 times those in their food. These compounds are accumulated in several tissues but mainly in lipid-rich tissues, such as the liver. Both DDT and PCBs alter physiological processes in birds. For example, DDE (a metabolite of DDT) apparently inhibits carbonic anhydrase and ATPase in the oveduct which results in eggs with thin shells that break during natural incubation or do not hatch at all. The populations of California brown pelicans have declined in recent years as a result of this, and the decline is slowing or possibly reversing as DDT pollution is abated.

Mercury is another wastewater constituent that is bioaccumulated by marine birds via the food web. The concentrations ingested and/or accumulated in the tissues may be lethal to the organism or have indirect effects such as reducing the hatchability of eggs. The sublethal effects of mercury and chlorinated hydrocarbons are summarized in Table III-C-24.

From this information it is apparent that discharges of chlorinated hydrocarbons and mercury in the HTP effluent could indirectly cause reproductive failures in marine birds through biomagnification in the food web. However, HTP is not the only source of these chemicals in the Southern California Bight, and thus as in mammals, the effects attributable to the HTP effluents cannot be quantified.

Marine Mammals. High levels of chlorinated hydrocarbons have been found in the tissues of marine mammals, particularly the blubber, with the highest values reported for industrialized areas. The mean concentration of DDT plus PCB in the blubber of harbor seals ranged from a low of 11.3 ppm at the Pribilof Islands to 610.7 ppm at San Miguel Island and 862.7 ppm in Puget Sound. The highest value reported was 2,350 ppm for a San Miguel seal. The effects of chlorinated hydrocarbons on marine mammals are generally unknown, although there is some evidence that DDT and PCB's may cause reproductive failure in Califronia sea lions by inducing premature pupping.

Heavy metals such as lead, cadmium, and mercury are also concentrated by marine mammals in various body tissues. Mercury is found mainly in the liver, cadmium in the kidneys, and lead in the hard tissues such as bone and teeth. Very little is known about the effects of metals on the physiology and ecology of marine mammals although mercury, selenium, cadmium, and bromine (not a metal) apparently play some role in the incidence of premature births of California sea lions. Lower concentrations of these elements were found in females having premature deliveries than in females having normal deliveries, but the atomic ratios of the elements in abnormal mothers were quite different from those for the normal mothers suggesting that a balance among elements is more important than the absolute concentration in determining heavy metal toxicity.

There are numerous sources of chlorinated hydrocarbons and heavy metals to the Southern California Bight, including HTP wastewater discharges. But because the rate of mobilization of these substances from *in situ* HTP particulates and their distribution in the dissolved form are not known, all that can be concluded is that constituents in the HTP effluent probably contribute to the body load of heavy metals and chlorinated hydrocarbons found in mammals of the Bight. The effects of these pollutants on the physiology and population ecology of marine mammals have yet to be determined, but it is probable that adverse effects occur.

C. Public Health Aspects. Although little is known about the direct public health impacts of HTP outfalls in Santa Monica Bay, several potential problems exist. As mentioned previously, pathogenic bacteria and viruses that do not die soon after discharge may contaminate fish or shellfish, rendering them unfit or dangerous for human consumption. Swimming or other water body contact sports near sewage outfalls may result in infections or illnesses although HTP discharges are of such a depth that effluents rarely reach the surface or shoreline during the summer swimming season. Bioaccumulation of toxicants such as heavy metals and chlorinated hydrocarbons is known to occur throughout the food web, and commercial catches of fish and shellfish are regulated by the FDA Standards (see Section III.C.2.f). The recreational fish and shellfish catches, however, are not regulated, and thus humans may be exposed to considerable amounts of toxicants from these sources taken near sewage outfalls. Furthermore, drug resistance (R factor) in bacteria may be transmitted from sewage to humans by way of ingesting contaminated water or poorly cooked fish and shellfish.

E. conclusions

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E. CONCLUSIONS

As indicated in Section III-C-3 of this chapter, the existing data on which this report is based are far from complete. A considerable amount of effort has been spent in this report attempting to present the various data sets in ways which increase their comparability - for example the colored isopleth plots based on relative rather than absolute values - but in the final analysis it has been extremely difficult to draw strong conclusions about the past effects of Hyperion Treatment Plant (HTP) discharges on the marine environment. The difficulties result from at least five kinds of problems, the first three of which are largely attributable to the fact that a considerably more detailed long-term study than has been undertaken so far would have been required to provide conclusive data. The five kinds of problems are 1) a lack of knowlege of physical processes such as sedimentation and circulation in Santa Monica Bay has apparently prevented the development of models for accurately predicting the disposition of sewage effluent, 2) sampling has been carried out (until very recently) using grids that were too coarse, both spatially and temporally, to resolve localized changes around the outfalls and in the Bay, 3) sampling and analytical techniques of the various agencies involved have not been comparable - a situation which has improved recently, 4) laboratory bioassay data are of only limited utility in assessing the potential effects of wastewater constituents on organisms, and 5) HTP represents only one source of pollutants to the Bight and its effects cannot be readily distinguished from those of the other sources.

The conclusions reached in this report are seldom strong since the existing evidence for adverse impacts is mainly circumstantial and the actual mechanisms of effects, for the most part, have yet to be demonstrated. Furthermore, the relationship between wastewater discharges and adverse environmental impacts may never be proven conclusively. The conclusions can be summarized as follows:

1. DISTRIBUTION AND FATE OF EFFLUENT CONSTITUENTS

- There is no question that there have been substantial alterations of the bottom sediments in the vicinity of the 7-mile sludge outfall. These changes include an accumulation of the sludge particulates which readily settled and which contain most, if not all, of their original toxic constituents. Earlier results suggest that the effects may extend to an area as much as 8 km on a side (see for example Figures III-B-19 through 28). Recent detailed sampling in the immediate vicinity of the 7-mile outfall suggests, however, that most sewage constituents in the sediments approach background levels within an area approximately 2 km on a side, located about 10 km from shore (see Figure II-B-14).

- The percentage of the particulates released by HTP that remain in the vicinity of the outfalls is not known. Calculations presented in this report suggest that a substantial proportion of those that have been released still remain, but definitive data are lacking. Similarly, the ultimate fate of these settleable particulates, be it displacement down Santa Monica Canyon by turbidity currents, eventual resuspension and wide distribution, or permanent deposition where they lie is not known. Some evidence is presented for each of these possibilities, but none of the evidence is conclusive. Laboratory studies have shown that some toxic substances are mobilized from suspended particulates, although this has not been demonstrated *in situ*. However, evidence has been presented that once the particulates settle to the bottom, further mobilization occurs slowly, if at all. The percentage of those toxic substances released from the outfalls that eventually end up distributed in the water rather than trapped in the sediments has not been adequately estimated, either theoretically or empirically.

- The distribution of sewage constituents in the water column has been documented to a much lesser extent than that in the sediments. This report illustrates distribution of the plume by showing the concentrations of total coliform bacteria at three different water depths during a single summer day (Figure III-B-9) and a single winter day (Figure III-B-10). For reasons indicated herein, coliform bacteria are not an ideal indicator for monitoring distribution of the plume, but except for unpublished work in progress on distribution of turbidity, they are the only constituent that has been monitored systematically. Weekly samples have been taken of coliform bacteria distribution for many years, and these two examples were chosen to reflect recurring characteristics of their distribution. They show that in summer there is a thermocline which inhibits bacteria of plume origin from reaching the surface, and hence, near-shore waters. Thus, contamination of the shoreline by the plume during summer is not likely to occur.

  In winter, the plume apparently surfaces and may reach shore. The example chosen for illustration, however, occurred after a rain, and the shoreline concentrations are probably a result of runoff. A considerably better picture of the plume would emerge were some constituent other than bacteria used for monitoring and were samples taken more frequently. In any case, there are no known epidemiological studies on the possible impact of the HTP outfalls on public health.

- Wastewater discharges may reduce the dissolved oxygen content of the receiving waters directly or indirectly. The dissolved oxygen concentrations near the HTP outfalls, however, do not appear to be lowered. The three nearshore basins (San Pedro, Santa Monica, and Santa Barbara) have reduced oxygen levels below the sill depth as a result of bacterial decomposition of organic matter from the natural high productivity (compared to offshore) of the nearshore surface waters settling out. Wastewater discharges along the coast may contribute to this organic matter directly or indirectly.

2. DISTRIBUTION AND ABUNDANCE OF ORGANISMS AS RELATED TO HTP DISCHARGES

- As would be expected, the distributions of some benthic organisms living in the sediments are correlated with the areas of known physical alteration. Apparently, there has been a substantial alteration in the biological characteristics of the bottom within the influence of the sludge outfall. The alteration is in the direction of decreased diversity (Figure III-C-16) and increased abundance (for some groups) and is by most definitions a degradation of the environment.

  The distribution of individual species are plotted as isopleths in this report from data for only one year (1972). The isopleths of species density presented herein should, therefore, be regarded as suggestive only. They show that some organisms (e.g., *Capitella capitata*) are strongly concentrated around the sludge outfall (Figure III-C-21), other organisms (e.g., *Capitita ambiseta*) are concentrated in the vicinity of the 5-mile (wastewater) outfall (Figure III-C-20), and still others (e.g., *Axinopsida sericata*) avoid both outfalls (Figure III-C-23). From these data it can be inferred that effluent from both outfalls is influencing benthic ecology. Better resolution will be obtained when species-specific data from later years are thoroughly analysed as well.

- The HTP effluent has been shown to periodically influence plankton in the surface waters of Santa Monica Bay with the zone of maximum plankton density moving offshore and decreasing after the 5-mile outfall went into operation. During most of the year, phytoplankton productivity was elevated in the surface waters over the outfall although the maximum productivity potential predicted from nutrient concentrations was not achieved, apparently as a result of the toxicants released with the nutrients.

  Red tides are caused by dinoflagellates which are generally outcompeted by diatoms where there is a continuous nutrient input. Thus, direct or indirect correlations of red tide blooms to sewage discharges are difficult to establish. The occurrence of red tide blooms, however, have shown no direct relationship to the HTP outfalls in the past.

- Some scientists feel very strongly that there has been a progressive deterioration of the marine environment in Santa Monica Bay, and that it is directly attributable to HTP effluent. However, definitive evidence that the recent historical changes in the biota of the nearshore environment of Santa Monica Bay have resulted from the release of HTP effluent from the present deep water outfalls is difficult to locate. Prior to 1961 much lower quality effluent was released one mile or less from shore which undoubtedly caused more nearshore impacts than the present deep water outfalls. In addition, surface runoff has been a continuing source of pollutants to the shoreline. This report clearly documents effects of HTP effluents on benthic biology well away from shore but has not found strong nearshore effects.

- In this report, some calculations are made on the potential contribution of nutrients originating in the HTP effluent to the commercial fishery (Figure III-C-38). The calculations are based on a number of simplifying assumptions and are designed to indicate the maximum amount of benefit that could occur as a result of the release of nutrients when, in fact, there is no evidence that such benefits ever accrue. The commercial fishery has generally been declining for many years (Figures III-C-35 and 36) while the amounts of effluent have been increasing. It has been postulated that the decline in the fishery is attributable to overfishing although pollution and habitat degradation may also be of some importance.

- The distribution and abundance of some fish species may be altered by the HTP discharges. Trawling data for 1958 through 1963 indicated that the mean number of species and the median number of fish per trawl were apparently lower near the HTP outfalls than in a control at the same depth.

3. UPTAKE AND TOXICITY OF SEWAGE CONSTITUENTS

- One method of deducing the biological distribution of toxic constituents of the effluent is to examine the tissues of organisms found in the vicinity of the outfalls; however, surprisingly little data have been collected. Concentrations of some metals in some benthic organisms were examined in 1972, and isopleths of these concentrations are included here (Figures III-C-31 and 32). The data show accumulations of some metals that are related to the outfalls, but the data are suspect because the metals may have been in sediments ingested by the organisms rather than in their tissues. Mussels suspended in the water column near the HTP 7-mile outfall did take up DDT and PCB, but since no spatial grid was set up the data are suggestive only. Furthermore, none of the benthic organisms living on either outfall pipe have been examined for uptake of toxic substances. Very limited sampling near the HTP outfalls suggests that fish living there concentrate chlorinated hydrocarbons to levels higher than those in fish found in non-outfall areas (Figure III-C-40).

- There is considerable evidence that the heavy metals and chlorinated hydrocarbons released from HTP could be directly toxic to organisms encountering them (Tables III-C-2 and 3). As detailed in this report, the concentrations of some constituents in the undiluted effluent are likely to be directly toxic to some marine organisms. Even after 100:1 dilution, some constituents may be toxic to some marine organisms in the vicinity of the outfall.

  Much more pervasive is the possibility that the constituents being released from the HTP outfalls may cause gradual sublethal effects throughout the food web and result in an altered species composition. These toxicants may be bioaccumulated in individual organisms, be concentrated through the web, and ultimately end up interfering with reproductive success of marine birds and mammals or end up in human food supplies. As detailed in this report, chlorinated hydrocarbons and heavy metals of the type released from HTP (but not necessarily in the same chemical form) do appear in the tissues of sport and commercial fish as well as in marine mammals and birds, where they are known to have deleterious effects. It has not been possible to trace any such contamination directly to HTP effluent, but since organisms in the Bight do concentrate these substances and since HTP does release them, it can be inferred that some percentage of the uptake is attributable to HTP.

- Wastewater discharges appear to increase the incidence of diseases and abnormalities in marine organisms. In fish, the incidence of tumors is apparently unrelated to wastewater outfalls while fin erosion disease is. Lip papillomas may be related to industrial pollution (e.g., the highest incidence was in Los Angeles-Long Beach Harbor), but the evidence is circumstantial. The cause of these diseases and abnormalities, however, is not known.

  In marine and shore birds thin eggshells are caused by DDE (a metabolite of DDT) which reduces their reproductive success. The populations of California brown pelicans have declined in recent years as a result of this, but the decline is slowing or possibly reversing as DDT pollution is abated. Mercury is another wastewater constituent that may reduce the hatchability of eggs.

  Premature pupping in California sea lions may be related to DDT, PCBs, and/or heavy metals such as mercury, cadmium, and selenium as well as bromine.

  The HTP outfalls are a major source of these problem constituents, and Los Angeles City discharges may reasonably be expected to contribute to these impacts.

In summary, although there is a substantial amount of information available on distribution and concentration of sewage constituents as well as the distribution and abundance of benthic organisms in Santa Monica Bay, the existing data do not provide many definitive answers to the question of what effects do the Hyperion Treatment Plant discharges have on the environment. A number of additional studies would be helpful in increasing the confidence with which impact predictions could be made for implementation of the Facilities Plan.

F. references

F. REFERENCES

Addison, R.F., and P.F. Brodie. 1973. Occurrence of DDT residues in Beluga whales (*Delphinopterus leucas*) from the Mackenzie Delta, Northwest Territory, Canada. J. Fish. Res. Bd. Canada. 30(11): 1033-1036.

Adema, D.M., S.I. de Swaaf-Mooy, and P. Bais. 1972. Laboratoriumonderzoek over de invloed van koper op mosselen (*Mytilus edilis* [sic])[in German, English summary]. T.N.O-Nieuws. 27(9): 482-487.

Ahlstrom, E.H. 1959. Vertical distribution of pelagic fish eggs and larvae off California and Baja California. U.S. Fish and Wildlife Serv., Fish. Bull. 161(60): 107-143.

Ahlstrom, E.H. 1965. Kinds and abundance of fishes in the California Current region based on egg and larval surveys. CalCOFI Rep. 10: 31-52.

Ahlstrom, E.H. 1969. Mesopelagic and bathypelagic fishes in the California Current region. CalCOFI Rep. 13: 39-44.

Allan Hancock Foundation. 1959. Oceanographic survey of the continental shelf area of southern California. State of California Resources Agency, State Water Poll. Control Bd. Pub. 20.

Allan Hancock Foundation. 1965. An oceanographic and biological survey of the southern California mainland shelf. Calif. State Water Qual. Control Bd. Pub. No. 27. 232 pp.

Allen, J. 27 May 1976. SCCWRP. Telecon.

Allen, M.J., H. Pecorelli, and J. Word. 1976. Marine organisms around outfall pipes in Santa Monica Bay. J. Water Poll. Control Fed. 48(8): 1881-1893.

Allen, M.J., J.B. Isaacs, and R.M. Voglin. 1975. Hook-and-line survey of demersal fishes in Santa Monica Bay. SCCWRP, TM222, El Segundo, CA. 23 pp.

Allen, W.E. 1933. Red water in La Jolla Bay in 1933. Science. 78: 12-13.

Allen, W.E. 1935. Yellow water in La Jolla Bay in 1935. Science. 82: 325-326.

Allen, W.E. 1938. Red water along the west coast of the United States in 1938. Science. 88: 55-56.

Preceding page blank

Allen, W.E. 1940. Discolored sea water. Hydrogr. Bull. No. 2662. U.S. Hydrogr. Off., Wash., D.C.

Allen, W.E. 1942. Occurrence of red water near San Diego. Science. 96: 471.

Allen, W.E. 1943. Red water in La Jolla Bay in 1942. Trans Amer. Microscop. Soc. 62: 262-264.

Allen, W.E. 1946. Red water in La Jolla Bay in 1945. Trans Amer. Microscop. Soc. 65: 149-153.

Alvarino, A. 1965. Distributional atlas of Chaetognatha in the California Current region. CalCOFI Atlas No. 3: 1-291.

Alvarino, A. 1967. Bathymetric distribution of Chaetognatha, Siphonophorae, medusae, and Ctenophorae off San Diego, California. Pac. Sci. 21(4): 474-485.

Amiard-Triquet, C. 1974. Etude de la decontamination d'Arenicola marina (Annedide, Polychete) apies contamination experimentale par le caesium 137 ou le cobalt 60 [in French, English summary]. Mar. Biol. 26(2): 161-165.

Amiard-Triquet, C. and J.C. Amiard. 1974. Contamination of marine trophic chains by ^{60}Co. Plaices and crabs fed with contaminated *Arenicola*. Nucl. Sci. Abs. 30(9): 2403.

Anas, R.E. 1974. DDT plus PCB's in blubber of Harbor Seals. Pesticides Monitoring J. 8(1): 12-14.

Anderlini, V. 1974. The distribution of heavy metals in the red abalone, *Haliotis rufescens* on the California coast. Arch. Env. Contamination and Toxicology. 2(3): 253-265.

Anderson, D. W., J. R. Jehl, Jr., R. W. Risebrough, L. A. Woods, Jr., L. R. Deweese, and W. G. Edgecomb. 1975. Brown Pelicans: Improved Reproduction off the Southern California Coast. Sci. 190: 806-808.

Anderson, D. W., R. M. Jurek, and J. O. Keith. 1977. The Status of Brown Pelicans at Anacapa Island in 1975. Calif. Fish and Game. 63(1): 4-10.

Anonymous. 1976. Environmental Reporter. 16(47). (incomplete ref.)

Atstatt, L.H., and R.R. Seapy. 1974. An analysis of sampling variability in replicated midwater trawls off Southern California. J. Exp. Mar. Biol. Ecol. 14: 261-273.

Aubert, M., R. Bittel, F. Laumond, M. Romeo, B. Donnier, and M. Barelli. 1972. Utilisation d'une chaine trophodynamique de type pelagique pour l'etude des transferts des pollutions metalliques [in French, English summary]. Rev. Internat. d'Oceanographie Medicale. 28: 27-52.

Aubert, M., M. Gauthier, B. Donnier, D. Pesando, J.M. Pincemin, and M. Barelli. 1972. Effets des pollutions chimiques vis-a-vis de telemediateurs intervenant dans l'ecologie microbiologique et planetonique en milieu marin [in French, English summary]. Rev. Internat. d'Oceanographie Medicale. 28: 129-166.

Bailey, R.M., J.E. Fitch, E.S. Herald, E.A. Lachner, C.C. Lindsey, C.R. Robins, and W.B. Scott. 1970. A list of common and scientific names of fishes from the United States and Canada. Am. Fish. Soc., Spec. Publ. No. 6: 1-150.

Baker, J.T.P. 1969. Histological and electron microscopical observations on Cu poisoning in the winter flounder (*Pseudopleuronectes americanus*). J. Fish. Res. Bd. Canada. 26: 2785-2793.

Barnard, J.L. 1961. Relationship of Californian amphipod faunas in Newport Bay and in the open sea. Pac. Nat. 2: 166-186.

Bascom, W. 1975. Sludge in the occean off southern California. SCCWRP. El Segundo, CA.

Becker, C.D., and T.O. Thatcher. 1973. Toxicity of power plant chemicals to aquatic life. Compiled for USAEC, Battelle Pac. NW Lab., Richland, WA.

Bell, R.R. 1974. Statistical report of fresh, canned, cured, and manufactured fishery products for 1972. Calif. Dept. Fish Game Circ. No. 47: 1-19.

Bell, R.R. 1971. California marine fish landings for 1970. Calif. Dept. Fish Game. Fish Bull. 154: 1-50.

Berner, L.D. 1967. Distributional atlas of Thaliacea in the California Current region. CalCOFI Atlas No. 8: 1-322.

Blus, L.J., T. Joanen, A.A. Belisle, and R.M. Prouty. 1975. The brown pelican and certain environmental pollutants in Louisiana. Bull. Env. Contamination and Toxicology. 13(6): 646-655.

Blus, L.J., B.S. Neely, Jr., A.A. Belisle, and R.M. Prouty. 1974. Organochlorine residues in brown pelican eggs: Relation to reproductive success. Env. Poll. 7(2): 81-91.

Boush, G.M., and F. Matsumura. 1973. Pesticide degradation by marine algae. Gov. Rep. Announcements. 73(6): 50.

Bowman, T.E. 1953. The systematics and distribution of pelagic Amphipoda of the families Vibiliidae, Paraphronimidae, Hyperiidae, Dairellidae, and Phroninidae from the Northern Eastern Pacific. Ph.D. Dissertation. UCLA.

Braham, H.W. 1973. Lead in the California sea lion (*Zalophus californianus*). Env. Poll. 5(4): 253-258.

Bright, D.B. 1974. Benthic invertebrates of the southern California coastal zone and offshore areas. So. Calif. Ocean Studies Consortium. The Port of Long Beach, CA.

Brinton, E. 1967. Distributional Atlas of Euphausiacea (Crustacea) in the California Current Region, Part I. CalCOFI Atlas No. 5: 1-275.

Brongersma-Sanders, M. 1957. Mass mortality in the sea. Pages 941-1011 *in* J.W. Hedgpeth, ed. Treatise on marine ecology and paleoecology. Vol. 1, Amer. Geol. Soc. Mem. 67.

Brungs, L.A. 1973. Effects of residual chlorine on aquatic life. J. Water Poll. Control Fed. 45: 2180-2193.

Brusca, G.J. 1967. The ecology of pelagic Amphipoda. I. Species accounts, vertical zonation and migration of Amphipoda from the waters off southern California. Pac. Sci. 21: 382-393.

Buelow, R.W., and P.M. Klazer. 1967. Comprehensive review of sewage chlorination. NE Mar. Health Sci. Lab., Narragansett, RI.

Bureau of Land Management (BLM). 1975. Final environmental statement of the proposed 1975 outer continental shelf oil and gas general lease sale offshore southern California. U.S. Dept. Int. Vol. 1 and 4.

Cabelli, V.J., A.P. Dufour, M.A. Levin, and P.W. Haberman. 1975. Criteria for marine microbiota. 25 pp. (incomplete ref.)

California Division of Mines and Geology. 1973. State of California preliminary fault and geology map, compiled by C.W. Jennings. Prelim. Rep. 13.

Caplan, R., and R. Boolootian. 1967. Intertidal ecology of San Nicolas Island. Pages 203-217 *in* Proc. Symp. Biol. Calif. Islands. Santa Barbara Bot. Garden, CA.

Carlisle, J.G., Jr. 1969. Results of a six-year trawl study in an area of heavy waste discharge: Santa Monica Bay, California. Calif. Fish Game. 55(1): 26-46.

Carlisle, J.G., Jr., O.H. Turner, and E.E. Ebert. 1964. Artificial habitat in the marine environment. Calif. Dept. Fish Game. Fish Bull. 124. 94 pp.

Carpenter, E.J., B.B. Peck, and S.J. Anderson. 1974. Summary of entrainment research at the Millstone Point Nuclear Power Station, 1970 to 1971. Pages 31-37 *in* L.D. Jensen (ed.), Proc. 2nd entrainment and intake screening workshop. EPRI Publ. No. 74-049-00-5, Palo Alto, CA.

Castle, W.T., and L.A. Woods, Jr. 1972. DDT residues in white croakers. Calif. Fish Game. 58(3): 198-203.

Chamberlain, D.W. 1974. A checklist of fishes from Los Angeles-Long Beach Harbors. Pages 43-78 *in* D.F. Soule and M. Oguri, eds., Marine studies of San Pedro Bay, California, Part IV. Allan Hancock Found. and Office of Sea Grant Programs. USC.

Chen, K.Y., and R.A. Lockwood. 1976. Evaluation strategies of metal pollution in ocean. ASCE. J. Eng. Div. 102(EE2): 347-359.

Childs, E.A., and J.N. Gaffke. 1973. Mercury content of Oregon groundfish. Nat. Mar. Fish. Serv. Fish. Bull. 71(3): 713-717.

Chow, T.J., and J.H. Earl. 1970. Lead aerosols in the atmosphere: increasing concentrations. Science. 169: 577-580.

Clendenning, K.A. 1958. Red tide studies. Ann. Prog. Rept. Scripps Inst. Ocean., Inst. Mar. Resour. Ref. 58-11.

Clendenning, K.A. 1971. Organic productivity in kelp area. Pages 259-264 *in* W.J. North (ed.), The biology of giant kelp beds (*Macrocystis*) in California. Nova Hedwigia, Suppl. 32, Cramer.

Cohen, J., and H.I. Shuval. 1973. Coliforms, fecal coliforms, and fecal streptococci as indicators of water pollution. Water, Air, and Soil Poll. 2(1): 85-95.

Cooke. 1973. Shell thinning in avian eggs by environmental pollutants. Env. Poll. 4(2): 85-152.

Cross, J. 4 March 1977. Hyperion Treatment Plant. Telecon.

Dale, I.M., M.S. Baxter, J.A. Bogan, and W.R.P. Bourne. 1973. Mercury in seabirds. Mar. Poll. Bull. 4(5): 77-79.

Dales, R.P. 1953. The distribution of some heteropod molluscs off the Pacific coast of North America. Proc. Zool. Soc. Lond. 122(4): 1007-1015.

Dames and Moore. 1973. Detailed environmental analysis concerning a proposed liquified natural gas project for Pacific Alaska LNG Company. Docket No. CP74.

Darrow, D.C., and R.F. Addison. 1973. The metabolic clearance of ^{14}C-p,p'-DDT from plasma and its distribution in the thorny skate, *Raja radiata*. Env. Phys. Biochem. 3(4): 196-203.

Darrow, D.C., and G.C. Harding. 1975. Accumulation and apparent absence of DDT metabolism by marine copepods, *Calanus* spp., in culture. J. Fish. Res. Bd. Canada. 32(10): 1845-1849.

Davies, A.G. 1974. The growth kinetics of *Isochrysis galbana* in cultures containing sublethal concentrations of mercuric chloride. J. Mar. Biol. Assoc. U.K. 54(1): 157-169.

Davies, J.E., and R. Rownd. 1972. Transmissible multiple drug resistance in Enterobacteriaceae. Science. 176: 758-768.

Davies, R.M., and L.D. Jensen. 1975. Zooplankton entrainment at three Mid-Atlantic power plants. J. Water Poll. Control Fed. 47(8): 2130-2142.

DeLong, R.L., W.G. Gilmartin, and J.G. Simpson. 1973. Premature births in California sea lions: association with high organochlorine pollutant residue levels. Science. 181: 1168-1170.

Department of Commerce. 1975a. San Diego to Santa Rosa Island, 21st ed. 18740 Loran-A overprinted (map).

Department of Commerce. 1975b. Point Dume to Purisima Point, 18th ed. 18720 Loran-A overprinted (map).

Department of Public Works (DPW). 1974. Terminal Island Treatment Plant Sludge and Effluent Disposal System. City of L.A. Proj. Rep.

Department of Public Works (DPW). 1973. Waste Discharges to the Ocean, Hyperion Treatment Plant, City of L.A., Parts I and II.

Department of Public Works (DPW). 1975a. City of L.A. Wastewater Facilities Plan, Final Draft (Preliminary).

Department of Public Works (DPW). 1975b. Draft Environmental Impact Report for the Hyperion Treatment Secondary Treatment Facility. Bureau of Engineering, City of L.A.

Department of Public Works (DPW). 1976. Environmental Impact Report, Hyperion Treatment Plant Secondary Treatment Facility. City of L.A.

Department of Public Works (DPW). 23 February 1976. City of Los Angeles. Office memorandum to Mr. A.D. Leipzig.

Dresnack, R., and J. Chack. 1973. A rational method of assessing the environmental impact of pollutional loads to the ocean. Pages 59-62 *in* 19th Proc. Inst. Env. Sci.

Dunstan, W.M. 1975. Problems of measuring and predicting influence of effluents on marine phytoplankton. Current Res. 9(7): 635-638.

Eganhouse, R.P., J.N. Johnson, D.R. Young, and D.J. McDermott. 1976. Mercury in southern California water: Inputs, distribution, and fate. SCCWRP, El Segundo, CA. 57 pp.

Engineering Science, Inc. (ESI). 1971. Report on ecosystem management alternatives Prepared for the City of Los Angeles. Engineering Science, Inc., Arcadia, CA.

Engineering Science, Inc., and Koebig and Koebig, Inc. (ESI and KKI). 1969. Feasibility study for Glendale-Los Angeles Water Reclamation Plant. Rep. prep. for Cities of Glendale and L.A., n.p.

Environmental Protection Agency. 1975. DDT, a review of scientific and economic aspects of the decision to ban its use as a pesticide, EPA-540/1-75-022. 300 pp.

Epifanio, C.E. 1973. Dieldrin uptake by larvae of the crab *Leptodius floridanus*. Mar. Biol. 19(4): 320-322.

Eppley, R.W., A.F. Carlucci, O. Holm-Hansen, D. Kiefer, J.J. McCarthy, and P.M. Williams. 1972. Evidence for eutrophication in the sea near southern California coastal sewage outfalls - July 1970. Calif. Mar. Res. Comm., CalCOFI Report 16: 74-83.

Establier, R. 1972. Concentracion de mercurio en los tejidos de algunos peces, moluscos y crustaceos del golfo de Cadiz y calderos del norolste africano [in Spanish, English summary]. Invest. Pesquera. 36(2): 355-364.

Fairbanks, D.A. 1969. Environmental factors affecting phytoplankton populations in Mission Bay. M.S. Thesis. San Diego State Coll. 136 pp.

Faisst, W.K. 1976. Digested sewage sludge: characterization of a residual and modeling for its disposal in the ocean off southern California. Env. Qual. Lab., Calif. Inst. Techn., Rep. No. 13. 193 pp.

Fauchald, K. 1971. The benthic fauna in the Santa Barbara Channel following the January 1969 oil spill. Pages 61-116 *in* D. Straughan, ed. Biological and oceanographical survey of the Santa Barbara Channel oil spill, 1969-1970. Vol. 1, Biology and bacteriology. Allan Hancock Found. USC.

Felts, R.W. 1973. Seasonal distribution and abundance of the chaetognaths from Anaheim Bay, California and the adjacent waters. M.S. Thesis. Calif. State Univ., Long Beach. 118 pp.

Fisher, N.S. 1975. Chlorinated hydrocarbon pollutants and photosynthesis of marine phytoplankton: A reassessment. Science. 189(4201): 463-464.

Fisher, N.S., and C.F. Wurster. 1973. Individual and combined effects of temperature and polychlorinated biphenyls on the growth of three species of phytoplankton. Env. Poll. 5(3): 205-212.

Fisher, N.S., L.B. Graham, E.J. Carpender, and C.F. Wurster. 1973. Geographic differences in phytoplankton sensitivity to PCB's. Nature. 241(3391): 548-549.

Fitch, 27 May 1976. California Department of Fish and Game Telecon.

Fitzgerald, G.A. 26 September 1975. Metal Finishing Assoc. of CA. Letter to J.H. McCall of the California Pollution Control Office.

Fowler, B.A., P.A. Wolfe, and W.F. Hettler. 1975. Trace metal uptake and toxicity to shellfish. Conference on heavy metals in the environment, II. Env. Health Perspectives. 10: 262-263.

Fowler, S.W., and G. Benayoun. 1974. Experimental studies of Cd flux through marine biota. Pages 155-178 *in* Comparative studies of food and environmental contamination. Proc. Int. Atom. Ener. Comm., Vienna.

Fowler, S.W., M. Heyraud, L.F. Small, and G. Benayoun. 1973. Flux of ^{141}Ce through a euphausiid crustacean. Mar. Biol. 21(4): 317-325.

Frank, R., K. Ronald, and H.E. Braun. 1973. Organochlorine residues in harp seals (*Pagophilus groenlandicus*) caught in eastern Canadian waters. J. Fish. Res. Bd. Canada. 30: 1053-1063.

Frey, H.W., ed. 1971. California's living marine resources and their utilization. Calif. Dept. Fish Game, Sacramento, CA. 148 pp.

Fugita, M., and K. Hashizume. 1975. Status of uptake of mercury by the fresh water diatom, *Synedra ulna*. Water Res. 9(10): 889-894.

Galloway, J.N. 1972. Man's alteration of the natural geochemical cycle of selected trace metals. Ph.D. Dissertation. UCSD.

Gardner, G.R., and G. LaRoche. 1973. Copper induced lesions in estuarine teleosts. J. Fish. Res. Bd. Canada. 30: 363-368.

Gaskin, D.E., G.J.D. Smith, P.W. Arnold, M.V. Louisy, R. Frank, M. Holdrinet, and J.W. McWake. 1974. Mercury, DDT, dieldrin, and PCB in two species of Odontoceti (Cetacea) from St. Lucia, Lesser Antilles. J. Fish. Res. Bd. Canada. 31: 1235-1239.

Gerba, C.P., and G.E. Schaiberger. 1975. Effect of particulates on virus survival in seawater. J. Water Poll. Control Fed. 47(1): 93-103.

Giam, C.S., M.K. Wong, A.R. Hanks, W.M. Sackett, and R.L. Richardson. 1973. Chlorinated hydrocarbons in plankton from the Gulf of Mexico and Northern Caribbean. Bull. Env. Contamination and Toxicology. 9(6): 376-382.

Gray, J.S., and R.J. Ventilla. 1973. Growth rates of a sediment-living marine protozoan as a toxicity indicator or heavy metals. Ambio. 2(4): 118-121.

Greichus, Y.A., D.J. Call, B.M. Ammann, A. Greichus, and H. Shane. 1975. Physiological effects of PCB's on a combination of DDT, DDD, and DDE in penned white pelicans. Arch. Env. Contamination and Toxicology. 3(3): 330-343.

Greichus, Y.A., A. Greichus, and R.J. Emerich. 1973. Insecticides, polychlorinated biphenyls and mercury in wild cormorants, pelicans, their eggs, food, and environment. Bull. Env. Contamination and Toxicology. 9(6): 321-328.

Greichus, Y.A., and M.R. Hannon. 1973. Distribution and biochemical effects of DDT, DDD, and DDE in penned double-crested cormorants. Toxicology and Appl. Pharmacology. 26(4): 483-494.

Grigg, R.W., and R.S. Kiwala. 1970. Some ecological effects of discharged wastes on marine life. Calif. Fish Game. 56(3): 145-155.

Hartman, O., and L.J. Barnard. 1960. The benthic fauna of the deep basins off southern California, Part 2. Allan Hancock Pac. Expeditions. 22(2): 68-297.

Hedgpeth, J.W. 1973. Temperature relationships of near shore oceanic and estuarine communities. Pages 1271-1432 *in* Effects and methods of control of thermal discharges, Part 3. Serial No. 93-14. U.S. Gov. Print. Off., Wash., D.C.

Hedgpeth, J.W. 1957. Sandy beaches. Pages 587-608 *in* J.W. Hedgpeth, ed., Treatise on marine ecology and paleoecology, Vol. 1. Amer. Geol. Soc. Mem. 67.

Heimann, R.F.G., and J.G. Carlisle. 1970. The California marine fish catch for 1968 and historical review 1916-1968. Calif. Dept. Fish Game. Fish Bull. 149: 1-70.

Heppleston, P.B., and M.C. French. 1973. Mercury and other metals in British seals. Nature. 243: 302-304.

Hewatt, W.G. 1946. Marine ecological studies on Santa Cruz Island, California. Ecol. Monogr. 16: 185-210.

Hodge, V.F., F.L. Hoffman, and T.R. Folsom. 1974. Rapid accumulation of plutonium and polonium on giant brown algae. Health Physics. 27(1): 29-35.

Holden, A.V. 1972. Present levels of mercury in man and his environment. Chap. 12. Pages 143-168 *in* Mercury contamination in man and his environment. Int. Atom. Ener. Comm., Tech. Rep. Ser. No. 137.

Howey, T.W. 1971. The occurrence and abundance of Copepoda in Anaheim Bay and the adjacent waters. M.S. Thesis. CSU, Long Beach. 87 pp.

Hyperion Treatment Plant (HTP). 1976. Annual report on monitoring programs for Hyperion Treatment Plant, Santa Monica Bay, Terminal Island Treatment Plant, Los Angeles Harbor, January 1, 1975 through December 31, 1975.

Icanberry, J.W., and J.R. Adams. 1974. Zooplankton survival in cooling water systems of four thermal power plants on the California coast. Pages 13-22 *in* L.D. Jensen, ed. Proc. 2nd Entrainment and Intake Screening Workshop. EPRI Publ. No. 74-049-00-5. Palo Alto, CA.

Ireland, M.P. 1974. Variations in zinc, copper, manganese, and lead content of *Balanus balanoides* in Cardigan Bay, Wales. Env. Poll. 7(1): 65-75.

Jackim, E. 1973. Influence of lead and other metals on fish δ-aminolevulinate dehydrase activity. J. Fish. Res. Bd. Canada. 30(4): 560-562.

Jackim, E., J.M. Hamlin, and S. Sonis. 1970. Effects of metal poisoning on five liver enzymes in the Killifish (*Fundulus heteroclitus*). J. Fish. Res. Bd. Canada. 27: 383-390.

Janiki, R., and W.B. Kinter. 1971. DDT: disrupted osmoregulatory events in the intestine of the eel, *Anguilla rostrata,* adapted to seawater. Science. 173: 1146-1148.

Jeffries, D.J., and J.L.F. Parslow. 1972. Effect of one polychlorinated biphenyl on size and activity of the gull thyroid. Bull. Env. Contamination and Toxicology. 8(5): 306-310.

Jensen, S., and A. Jernelöv. 1972. 4. Behavior of mercury in the environment. Pages 43-47 *in* Mercury contamination in man and his environment. Tech. Rep. Ser. No. 137. Int. Atom. Ener. Comm., Vienna.

Johnson, P.T. 1971a. Studies on unhealthy-appearing urchins from Whites Point. *In* W.J. North, ed. 1970-71 Ann. Rep. Kelp Habitat Improvement Proj. W.M. Keck Lab., Calif. Inst. Tech., Pasadena, CA.

Johnson, P.T. 1971b. Studies from diseased urchins from Point Loma. *In* W.J. North, ed. 1970-71 Ann. Rep. Kelp Habitat Improvement Proj. W.M. Keck Lab., Calif. Inst. Tech., Pasadena, CA.

Jones, G.F. 1969. Benthic macrofauna of the mainland shelf of southern California. Allan Hancock Found. Monogr., Mar. Biol. 4: 1-219.

Jones, J.H. 1971. General circulation and water characteristics in the Southern California Bight. SCCWRP, El Segundo, CA. 37 pp.

Jones, M.B. 1973. Influence of salinity and temperature on toxicity of mercury to marine and brackish water isopods (Crustacea). Estuar. Coast. Mar. Sci. 1(4): 425-431.

Kamps, L.R., R. Carr, and H. Miller. 1972. Total mercury-monomethylmercury content of several species of fish. Bull. Env. Contamination Toxicology. 8(5): 273-279.

Keen, A.M., and E. Coan. 1974. Marine molluscan genera of western North America: An illustrated key. 2nd ed. Stanford Univ. Press, Stanford, CA. 208 pp.

Kerfoot, W.B., and S.A. Jacobs. 1976. Cadmium accrual in combined wastewater treatment - aquaculture system. Env. Sci. Tech. 10(7): 602-667.

Kim, K.C., R.C. Chu, and G.P. Barron. 1974. Mercury in tissues and lice of northern fur seals. Bull. Env. Contamination and Toxicology. 2(3): 281-284.

Kinshore, R., and V. Guinn. 1972. Report for the IDOE workshop on baseline measurements. Pages 105-120 *in* Baseline studies of pollutants in the marine environment. (incomplete ref.)

Kiyoura, R. 1964. Water pollution and Minamata disease. Adv. Water Poll. Res. 3: 291-293.

Klensmer, H., S.N. Laoma, and L.S. Tau. 1973. Mercury levels in marine biota. Gov. Rep. Announcements. 73(10): 76.

Koditschek, L.K., and P. Guyre. 1974. Antimicrobial-resistant coliforms in New York Bight. Mar. Poll. Bull. 5(5): 71-74.

Koeman, J.H., W.S.M. van de Ven, J.J.M. de Goeij, P.S. Tjioe, and J.L. van Haaften. 1975. Mercury and selenium in marine mammals and birds. Sci. Total Env. 3(3) 279-287.

Koeman, J.H., H. Rothof, R. de Vries, H. van Velzen-Blad, and J.G. Vos. 1972. The impact of persistent pollutants on piscivorous and molluscivorous birds. T.N.O.-Nieuws. 27(10): 561-569.

Kolpak, R. 2 March 1977. Department of Geology, USC. Telecon.

Kremer, T. 29 April 1977. Personal communication.

Lackey, J.B. 1967. The microbiota of estuaries and their roles. Pages 291-302 *in* G.H. Lauff, ed. Estuaries. Amer. Assoc. Adv. Sci., Publ. No. 83.

Lackey, J.B., and K.A. Clendenning. 1963. A possible fish-killing yellow tide in California waters. J. Fla. Acad. Sci. 26: 263-268.

Lackey, J.B., and K.A. Clendenning. 1965. Ecology of the microbiota of San Diego Bay, California. Trans. San Diego Soc. Nat. Hist. 14(2): 9-40.

LeBlanc, P.J., and A.L. Jackson. 1973. Arsenic in marine fish and invertebrates. Mar. Poll. Bull. 4(6): 88-90.

Longcore, J.R., and F.B. Samson. 1973. Eggshell breakage by incubating black ducks fed DDE. J. Wildlife Man. 37(3): 390-394.

MacInnes, J.R., and F.P. Thurberg. 1973. Effects of metals on the behavior and oxygen consumption of the mud snail. Mar. Poll. Bull. 4(12): 185-186.

Marconsults, Inc. 1971. Santa Monica Bay natural oil seeps investigation; Rep. to Standard Oil Co., CA., n.p.

Marine Advisors, Inc. 1963. Oceanographic investigation for proposed Cardiff-Solana Beach sewage outfall. Prep. for Spec. Distr. Serv., Co. San Diego. 23 pp.

Martin, J.H., P.D. Elliott, V.C. Anderlini, D. Girvin, S.A. Jacobs, R.W. Risebrough, R.L. Delong, and W.G. Gilmartin. 1976. Mercury-selenium-bromine imbalance in premature parturient California sea lions. Mar. Biol. 35: 91-104.

May, B. 1976. When the seas run red - and the dinoflagellates bloom. Oceans. 9(6): 52-56.

McDermott, D.J., D.R. Young, and T.C. Heesen. 1975. Polychlorinated biphenyls in marine organisms of southern California. SCCWRP, El Segundo, CA. 45 pp.

McErlean, A.J., C. Kirby, and R.C. Swartz. 1972. Discussion of the status of knowledge concerning sampling variation, physiological tolerances, and possible change criteria for bay organisms. Ches. Sci. 135: 542-554.

McGinnis, D.R. 1971. Observations on the zooplankton of the eastern Santa Barbara Channel from May, 1969 to March, 1970. Pages 49-59 *in* D. Straughan, ed. Biological and oceanographic survey of the Santa Barbara Channel oil spill 1969-1970. Vol. I, Biology and bacteriology. Allan Hancock Found. USC.

McGowan, J.A. 1967. Distributional atlas of pelagic molluscs in the California Current region. CalCOFI Atlas No. 6: 1-218.

Mearns, A. J. 26 August 1977. SCCWRP. Personal communication.

Mearns, A.J., M.J. Allen, and M. Sherwood. 1974. An otter trawl survey of Santa Monica Bay, May-June 1972. SCCWRP, TM 209, El Segundo, CA. 24 pp.

Mearns, A.J., M.J. Allen, L.S. Word, J.Q. Word, C.S. Greene, M.J. Sherwood, and B. Myers. 1976. Quantitative responses of demersal fish and benthic invertebrate communities to coastal municipal wastewater discharges. SCCWRP Final Rep., EPA Grant R801152, Vol. 1 and 2.

Mearns, A.J., and C.S. Greene. 1974. A comparative trawl survey of three areas of heavy waste discharge. SCCWRP, El Segundo, CA. 76 pp.

Mearns, A.J., and M.J. Sherwood. In Press. Distribution of neoplasms and other diseases in marine fishes relative to the discharge of wastewater. Ann. New York Acad. Sci.

Mearns, A.J., and M.J. Sherwood. 1974. Environmental aspects of fin erosion and tumors in southern California Dover sole. Trans. Am. Fish. Soc. 103(4): 794-310.

Meyers, E.P. 1974. The concentration and isotopic composition of carbon in marine sediments affected by a sewage discharge. Ph.D. Thesis. Calif. Inst. of Tech., Pasadena, CA.

Miller, B.S., and S.R. Wellings. 1971. Epizootiology of tumors in flathead sole (*Hippoglossoides elassodon*) in East Sound, Orcas Island (Washington). Trans. Am. Fish. Soc. 100(2): 247-266.

Miller, D.J., and R.N. Lea. 1972. Guide to the coastal marine fishes of California. Calif. Dept. Fish Game, Fish Bull. 157: 1-235.

Mitchell, R., F. Walsh, and P. Asketh. 1973. Sublethal effects of pollutants on activities of marine micro-organisms. I. Ecological implications of chemotaxis by marine bacteria. II. Inhibition of inter-microbial predation by chlorinated hydrocarbons. Gov. Rep. Announcements. 74(4): 50.

Morel, F.M.M., J.C. Westall, C.R. O'Melia, and J.J. Morgan. 1975. Fate of trace metals in Los Angeles county wastewater discharge. Env. Sci. Tech. 9(8): 756-761.

Mosser, J.L., T.C. Teng, W.G. Walther, and C.F. Wurster. 1974. Interactions of PCB's, DDT and DDE in a marine diatom. Bull. Env. Contamination Toxicology. 12(6): 665-668.

Nagano, J. 18 November 1976. City of Los Angeles. Inter-departmental correspondence to W.F. Garber.

Neison, T.M. 1969. Population structure, dynamics, breeding cycles and ecotypic variation in San Diego populations of the sand dollar, *Dendraster excentricus* (Eschscholtz). M.A. Thesis. San Diego State Coll. 241 pp.

Neushul, M., W.D. Clarke, and D.W. Brown. 1967. Subtidal plant and animal communities of the southern California islands. Pages 37-55 *in* R.N. Philbrick, ed. Proc. Sym. Bio. Calif. Islands. Santa Barbara Bot. Garden, CA.

Nicholson, N.L., and R.L. Cimberg. 1971. The Santa Barbara oil spills of 1969: A post-spill survey of the rocky intertidal. Pages 325-399 *in* D. Straughan, ed. Biological and oceanographical survey of the Santa Barbara Channel oil spill 1969-1970. Vol. 1. Biology and bacteriology. Allan Hancock Found. USC.

North, W. J. July 27, 1977. Telecon.

North, W.J., ed. 1971. The biology of giant kelp beds (*Macrocystis*) in California. Beihefte Nova Hedwigia. 32: 1-600.

North, W.J., and C.L. Hubbs, eds. 1968. Utilization of kelp-bed resources in southern California. Dept. Fish Game, Fish Bull. 139. Chap. 5, 6, and 8.

North, W.J., and J.S. Pearse. 1970. Sea urchin population explosion in southern California coastal waters. Science. 170: 209.

Odell, D.K. 1971. Censuses of pinnipeds breeding on the California Channel Islands. J. Mamm. 52: 187-190.

Oguri, M. 1974. Primary productivity in the outer Los Angeles harbor. *In* D.F. Soule and M. Oguri, eds. Marine studies of San Pedro Bay, California, Part IV. Allan Hancock Found. Sea Grant Prog. USC.

Ohara, G. 4 March 1977. Hyperion Treatment Plant. Telecon.

Oliphant, et al. 1973. California marine fish landings for 1971. Calif. Dept. Fish Game, Fish Bull. 159: 1-49.

Oshida, P.S., A.J. Mearns, D.J. Reish, and C.S. Word. 1976. The effects of hexavalent and trivalent chromium on *Neanthes arenaceodentata* (Polychaeta: Annelida). SCCWRP, El Segundo, CA. 58 pp.

Pavilic, J., and T. Jaervenpaeae. 1974. Cadmium toxicity in adults and early larval stages of the mussel, *Mytilus galloprovincialis,* Lem. Pages 155-178 *in* Comparative studies of food and environmental contamination. Proc. Ser. Int. Atom. Ener. Comm., Vienna.

Peakall, D.B. 1975. Physiological effects of chlorinated hydrocarbons on avian species. Pages 343-360 *in* R. Haque and V.H. Freed, eds. Environmental dynamics of pesticides. Plenum Press, New York.

Peakall, D.B., D.S. Miller, and W.B. Kinter. 1975. Prolonged eggshell thinning caused by DDE in the duck. Nature. 254(5499): 421.

Pentreath, R.J. 1973. The accumulation from water of ^{65}Zn, ^{54}Mn, ^{58}Co, and ^{59}Fe by the mussel, *Mytilus edulis*. J. Mar. Biol. Assoc. U.K. 53(1): 18 pp. (sic).

Pequegnat, W.E. 1963. Population dynamics in a sublittoral epifauna. Pac. Sci. 17: 424-430.

Pequegnat, W.E. 1964. The epifauna of a California siltstone reef. Ecology. 45(2): 272-283.

Pequegnat, W.E. 1966. Distribution of epifauna biomass on a sublittoral rock-reef. Pac. Sci. 22: 37-40.

Pinkas, L., M.S. Oliphant, and C.W. Haugen. 1968. Southern California marine sportfishing survey: private boats, 1964; shoreline, 1965-66. Calif. Dept. Fish Game, Fish Bull. 143: 1-42.

Portmann, J.E. 1970. Results of acute toxicity tests with marine organisms using a standard method. FAO Tech. Conf. Mar. Poll. and its Effects on Living Resources and Fish. Rome.

Reid, F.M.H., E. Fuglister, and J.B. Jordan. 1970. Phytoplankton taxonomy and standing crop. Pages 51-661 *in* J.D.H. Strickland, ed. The ecology of the plankton off La Jolla, California, in the period April through September 1967. Scripps Inst. Oceanogr. Bull. 17.

Reish, D.J. 1964. Studies on the *Mytilus edulis* community in Alamitos Bay, California: II. Population variations and discussion of the associated organisms. Veliger. 6(4): 202-207.

Renfro, W.C. 1975. Transfer of ^{65}Zn from sediments by marine polychaete worms. Int. Atom. Ener. Comm. Radioact. in the Sea Publ. 46. 36 pp.

Rice, C.P., and H.C. Sikka. 1973a. Fate of dieldrin in selected species of marine algae. Bull. Env. Contamination and Toxicology. 9(2): 116-123.

Rice, C.P., and H.C. Sikka. 1973b. Uptake and metabolism of DDT by six species of marine algae. J. Agri. Food Chem. 21(2): 148-152.

Ricketts, E.F., and J. Calvin. 1968. Between pacific tides, 4th ed. rev. by J.W. Hedgpeth. Stanford Univ. Press, Palo Alto, CA. 614 pp.

Roberts, D. 1975. The effects of pesticides on byssus formation in the common mussels, *Mytilus edulis*. Env. Poll. 8(4): 241-254.

Robertson, D.E., L.A. Rancitelli, J.C. Langford, and R.W. Perkins. 1972. Pages 231-273 *in* Baseline studies of pollutants in the marine environment. Battelle-NW Contribution to the IDOE Baseline Study.

Rohatgi, N., and K.Y. Chen. 1975. Transport of trace metals by suspended particulates on mixing with seawater. J. Water Poll. Control Fed. 47: 2298-2316.

Russel, F.E., and P. Kotin. 1957. Squamous papillomas in the white croaker. J. Nat. Cancer Inst. 18(6): 857-861.

Schulz-Baldes, M. 1973. Die Meismuschel, *Mytilus edulis*, als Indikator fuer die Bleikonzentiation in Weseraestuar und in der Deutschen Bucht [in German, English summary]. Mar. Biol. 21(2): 98-102.

Seapy, R.R. 1974. Zooplankton of southern California, a literature survey. So. Calif. Ocean Studies Consortium. The Port of Long Beach, CA, n.p.

Setzer, R.B. 1974. Preliminary investigations of benthic marine algae from the breakwaters protecting Los Angeles and Long Beach Harbors. *In* D.F. Soule and M. Oguri, eds. Marine Studies of San Pedro Bay, California, Part IV. Allan Hancock Found. and Sea Grant Programs. USC.

Sherwood, M.J., and A.J. Mearns. 1976. Occurrence of tumor-bearing Dover sole (*Microstomus pacificus*) off Point Arguello, California and off Baja California, Mexico. Trans. Am. Fish. Soc. 105(4): 561-563.

Sherwood, M.J., and A.J. Mearns. 1974. Disease responses in southern California fishes. Proc. Conf. Mar. Biol., Env. Protect. Rep. NUC TP 443.

Sindermann, C.J., and A. Rosenfield, 1967. Principle diseases of commercially important marine bivalve Mollusca and Crustacea, Fish. Bull. 66: 335-385.

Southern California Coastal Water Research Project (SCCWRP). 1973. The ecology of the Southern California Bight: Implications for Water Quality Management. El Segundo, CA.

Southern California Coastal Water Research Project (SCCWRP). 1974. Coastal Water Research Project, 1974. Ann. Rep. El Segundo, CA.

Southern California Coastal Water Research Project (SCCWRP). 1975a. Coastal Water Research Project. Ann. Rep. El Segungo, CA.

Southern California Coastal Water Research Project (SCCWRP). 1975b. Environmental Effects of the Disposal of Municipal Wastewater in Open Coastal Waters. El Segundo, CA.

Southern California Coastal Water Research Project (SCCWRP). 1976. Annual Report. El Segundo, CA. 263 pp.

Southern California Edison Company (SCE). 1973. Thermal Effect Study, San Onofre Nuclear Generating Station Unit 1, Vol. 1. Environmental Quality Analysts, Inc., and Marine Biological Consultants, Inc., for SCE and San Diego Gas and Electric Company. n.p.

Sowby, M.L. 1973. The seasonal abundance and distribution of decapod larvae in Anaheim Bay, California. M.S. Thesis. California State Univeristy, Long Beach. 144 pp.

Stagg, C.H. 23 April 1976. Baylor School of Medicine. Letter.

Stapleton, R.P. 1968. Trace elements in tissues of the calico bass, *Paralabrax clothestus* (Girard). Bull. So. Calif. Acad. Sci. 67(1): 49-58.

State Water Quality Control Board (SWQCB). 1964. An investigation of the effects of discharged wastes on kelp. State of California. Publ. No. 26. 124 pp.

State Water Resources Control Board (SWRCB). 1972. Water quality control plan for ocean waters of California. State of California, The Resources Agency.

State Water Quality Control Board (SWQCB). 1974. Tentative Water Quality Control Plan Report. State of California.

State Water Resources Control Board. 1975. A "state-of-the-art" review of health aspects of wastewater reclamation for groundwater recharge. State Water Resources Control Board, Dept. Water Resources and Dept. Health. State of California.

Stenner, R.D., and G. Nickless. 1974. Absorption of Cd, Co, and Zn by dog whelks in the Bristol Channel. Nature. 247(5438): 198-199.

Stephens, J.S. Jr., C. Terry, S. Subber, and M.J. Allen. 1974. Abundance, distribution, seasonality, and productivity of the fish populations in Los Angeles Harbor, 1972-73. Pages 1-42 *in* D.F. Soule and M. Oguri, eds. Marine studies of San Pedro Bay, California, Part IV. Allan Hancock Found. and Sea Grant Programs. USC.

Stevenson, R.E., and J.R. Grady. 1956. Plankton and associated nutrients in waters surrounding three sewer outfalls in southern California: Rept. to Hyperion Eng., Inc. Geol. Dept., USC.

Straughan, D., ed. 1971. Biological and oceanographical survey of the Santa Barbara Channel oil spill 1969-1970. Vol. 1. Biology and bacteriology. Allan Hancock Found. USC. 426 pp.

Straughan, D. 1975. Intertidal sandy beach macrofauna at Los Angeles-Long Beach Harbor. *In* D.F. Soule and M. Oguri, eds. Marine Studies of San Pedro Bay, California, Part 8. Allan Hancock Found. and Sea Grant Programs. USC.

Straughan, D. 1976. Sublethal effects of natural chronic exposure to petroleum in the marine environment. Allan Hancock Found. API Pub. No. 4280. 119 pp.

Sudo, R., and S. Aiba. 1973. Effects of copper and hexavalent chromium of the specific growth rate of ciliata isolated from activated sludge. Water Res. 7(9): 1301-1307.

Sweeney, B.M., and K.A. Clendenning. 1958. The phytoplankton of San Diego Bay. Quart. Prog. Rept., October 1-December, 1957. Scripps Inst. Ocean., Inst. Mar. Resour. Ref. 58-2: 1-16.

Thomas, W.H. 1972. Nutrients, chlorophyll, and phytoplankton productivity near southern California sewage outfalls. Scripps Inst. Ocean., Inst. Mar. Resour. Ref. No. 72-19. 77 pp.

Triquet, C. 1973. Etude de la contamination d'*Arenicola marina* L. (Annelide, Polychaete) par le colbalt-60 [in French, English summary]. Academie des Sciences, Paris. Comp. Rend. Hebdomadaues des Seances - Serie D. Sci. Nat. 276(4): 645-648.

Turner, C.H., E.E. Ebert, and R.R. Given. 1969. Man-made reef ecology. Calif. Dept. Fish Game, Fish Bull. 146: 1-221.

United States Department of the Interior. 1974. United States List of Endangered Fauna. Fish and Wildlife Serv., Wash., D.C.

Valentine, D.W., and M. Soule. 1973. Effect of p,p'DDT on developmental stability of pectoral fin rays in the grunion, *Leuresthes tenuis*. Nat. Mar. Fish. Serv., Fish. Bull. 11(4): 921-926.

Vind, H.P., J.S. Muraoka, and C.W. Mathews. 1975. The survival of sewage bacteria at various ocean depths. Civil Eng. Lab., Tech. Note N-1396. 20 pp. (incomplete ref.)

Waldichuk, M. 1974. Coastal marine pollution and fish. Ocean Man. 2: 1-60.

Ward, C.H. 3 June 1976. Rice University. Telecon.

Water Resources Engineers, Inc. 1965. Effects of digested sludge discharge on the ocean environment near the City of San Diego Outfall. Rep. to the SWQCB.

Weis, J.S., and P. Weis. 1975. Retardation of fin regeneration in *Fundulus* by several insecticides. Trans. Am. Fish. Soc. 104: 135-137.

Williams Brothers Environmental Services. 1976. West Coast - Mid-Continent Pipeline Project. EIA, Prep. for SOHIO Trans. Co.

Windom, H., F. Taylor, and R. Stickney. 1973. Mercury in North Atlantic plankton. Internat. Council Explor. of the Sea, J. Conseil. 35(1): 18-21.

Won, W.D., and H. Ross. 1973. Persistence of virus and bacteria in seawater. ASCE, J. Env. Eng. Div. 99(EE3): 205-211.

Word, J.Q., and D.K. Charwat, eds. 1975. Invertebrates of the southern California coastal waters. I. Select groups of annelids, arthropods, eclimoderms, and molluscs. SCCWRP. El Segundo, CA. 163 pp.

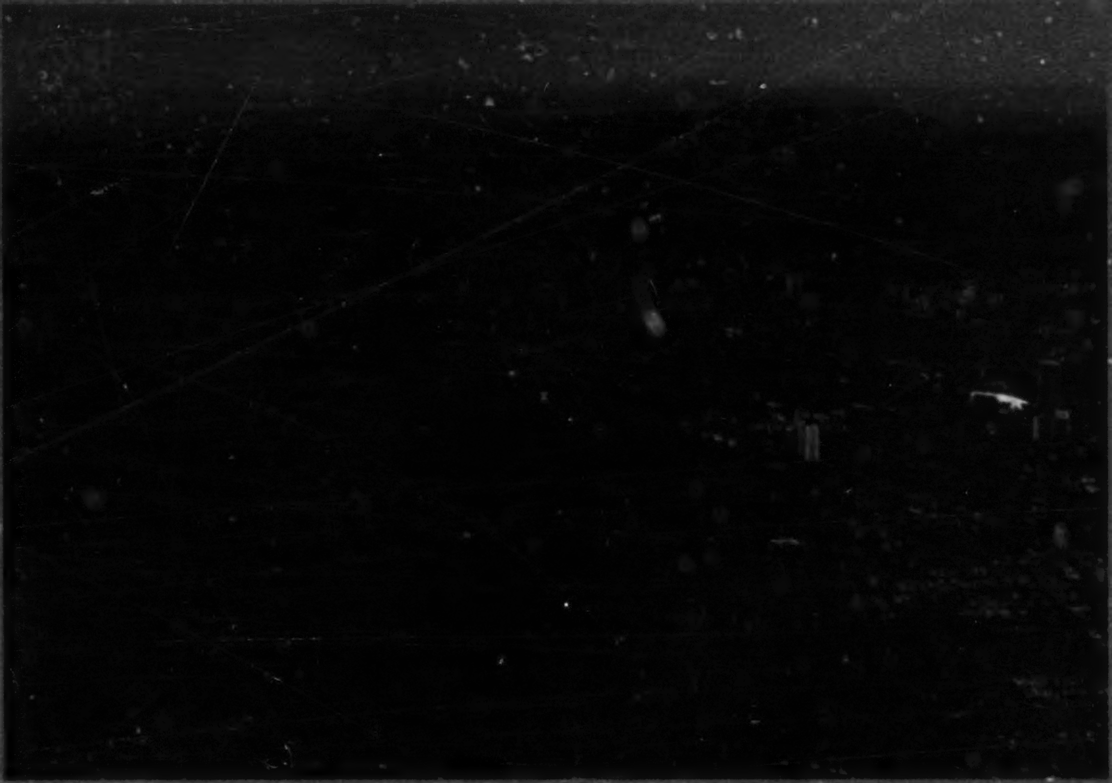
Word, J.Q. 17 June 1976. SCCWRP. Personal communication.

Young, P.H. 1964. Some effects of sewer effluent on marine life. Calif. Fish Game. 50: 33-41.

Young, P.H. 1973. Partyboat logs show how skin and SCUBA divers fared - 1965 through 1970. Calif. Dept. Fish Game. 59(1): 62-72.

Young, D.R., D.J. McDermott, and T.C. Heesen. 1975. Polychlorinated biphenyl inputs to the Southern California Bight. SCCWRP. El Segundo, CA. 50 pp.

Young, D.R. 18 June 1976. SCCWRP. Telecon.



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Chapter IV

legal and institutional constraints affecting the plan

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A. introduction

IV-1

A. INTRODUCTION

1. ORGANIZATION OF THE CHAPTER

The legal and institutional constraints affecting the Facilities Plan are explained in this chapter of the EIS in order to clearly separate them from physical and environmental constraints. These legal and institutional constraints tend to be formalized or controlled in a readily identifiable manner. They are found in organizations representing the general public and include legally enforceable requirements as well as adopted or widely accepted policies or goals.

Influences on the supply and demand of any factors affecting the need for wastewater treatment facilities are additional constraints but these are not as formalized nor so readily controlled.

While the Facilities Plan is intended to meet the wastewater treatment needs of the service area, the determination of these requirements over the economic life span of the proposed project is difficult and subject to a broad variety of interpretations. Facilities needs are determined basically by the difference between what enters the treatment plant versus what leaves it. What the plant discharges is to a large extent regulated by legal constraints. With some exceptions, what enters the plant is not subject to direct legal restraints, but is dependent upon demographic and economic characteristics of the service area. The future population and economy of the area, in turn, are influenced by institutional and other constraints such as the availability of utilities, transportation networks, land, etc. A Facilities Plan is designed to predict service area needs and devise technically and economically feasible means of treating user discharges so that the treatment facilities' effluents meet all applicable requirements.

Predictions of future characteristics of the service area are used to estimate the quantity and quality of influent to be processed at the wastewater treatment facilities. Regional and local land use regulations influence growth and economics in a relatively predictable manner. Other influences, such as the availability of energy supplies, are less predictable but significant.

Chapter IV presents the roles of major agencies at federal, state, regional, and local levels which are responsible for determining and/or enforcing institutional constraints. Section IV.B includes a description of major environmental review procedures which apply to the Facilities Plan.

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Constraints affecting facilities planning and implementation are discussed in this chapter under three major categories:

- Water Quality Controls and Planning (Section IV.C)
- Air Quality Controls and Planning (Section IV.D)
- Land Use and Transportation Controls and Planning (Section IV.E)

The constraints on water and air quality are primarily legally enforceable institutional constraints that are closely interrelated with the less formal land use, planning, and transportation constraints.

2. OVERVIEW OF CONSTRAINTS

The main objectives of the Facilities Plan are

- To meet the more stringent state and federal effluent requirements
- To replace outdated and deteriorating equipment and structures
- To accommodate minimal anticipated increases in population
- To protect and enhance the environment

The first project objective sets forth the constraints most directly affecting facilities planning. Federal legislation, supported by corresponding state law, requires that full secondary treatment be provided by July 1, 1977, for all effluents discharged to receiving waters from the City's waste treatment facilities. A second major federal requirement is that the City discontinue the practice of discharging sewage sludge to the ocean. The regional sludge disposal issue is being evaluated by a study separate from the Facilities Plan, but the Facilities Plan recognizes that an interim sludge disposal method must be sought. In addition to meeting specific effluent requirements, the facilities must be planned to accommodate goals for reclaiming water and for restoring beneficial uses of surface waters. Federal, state, regional, and local water quality regulations and policies for the Los Angeles area have been incorporated into the "Water Quality Control Plan Report, Los Angeles River Basin" (Regional Water Quality Control Board, March 1975). The Facilities Plan is required to be in conformance with the "Water Quality Control Plan Report," and to comply with all applicable rules and regulations relating to water quality.

Extensive plant modification and expansion required to provide full secondary treatment will be accompanied by replacement of obsolete and deteriorating facilities. The constraints affecting planning for this objective are primarily technical engineering considerations of plant design. Technical considerations are only discussed where they potentially impact on environmental quality goals.

The objective of accommodating population increases is complicated by the necessity to determine the magnitude and location of the population change. While planning should be based upon the most likely growth to occur, the issue is not so much absolute growth but the location of that growth. An unpredicted shift of population may place severe strain upon existing facilities and render other facilities unnecessary. As a further complication, wastewater capacity itself may contribute to locational decisions (Environmental Impact Center, 1975).

The critical air quality problems of the Los Angeles Basin require solutions involving comprehensive land use and transportation planning. The City's Facility Plan is intended to meet the wastewater treatment needs of the service area until the year 2000 without detrimentally affecting air quality by encouraging growth which would not otherwise occur. Full implementation of the proposed plan will depend on whether or not the plan is judged during the review phase to provide adequate service without inducing growth. Implementation of elements of the plan scheduled for construction after the initial phase will depend partly on the accuracy of service area need projections used in the planning phase.

B. agency roles

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B. AGENCY ROLES

Most institutional constraints affecting facilities planning are applied through a hierarchy of governmental agencies from the federal to the local level. Federal laws are frequently implemented through state or local agencies under federal approval. State agencies usually are allowed to impose regulations more strict than federal requirements, but not less strict. Similarly, regional or local agencies are often permitted to have controls more, but not less, strict than those imposed by state agencies.

Whereas water and air quality controls generally are initiated through state and federal agencies, land use controls frequently originate with regional or local agencies. Environmental review occurs at both federal and local levels in California, with agencies requiring impact assessments and periods for public review and comment on major federal and/or state and local governmental actions.

1. FEDERAL AGENCIES

Major federal legislation covering environmental review is handled through the Council on Environmental Quality. Federal environmental quality programs and regulations are under the direction of the U.S. Environmental Protection Agency.

a. Council on Environmental Quality. The Council on Environmental Quality (CEQ) was established on January 1, 1970 by PL 91-190, the National Environmental Policy Act (NEPA). The CEQ advises the President on matters relating to the environmental quality of the nation and reviews programs of the federal government that are covered by NEPA. NEPA assigns to CEQ the responsibility of issuing guidelines to federal agencies for the preparation of Environmental Impact Statements (EISs) as required by NEPA for any federal actions significantly affecting the quality of the human environment. Revised guidelines for the preparation of EISs were published by CEQ on August 1, 1973 (CEQ, August 1973). CEQ reviews all EISs; they comment on the environmental acceptability of the proposed actions and the adequacy of the EISs to provide full disclosure of expected environmental impacts and to evaluate alternatives.

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Since partial funding for the City of Los Angeles' proposed wastewater treatment facilities is provided by a federal agency (the Environmental Protection Agency, EPA), an EIS on the Facilities Plan is required and must be prepared by the EPA. The CEQ receives the Environmental Impact Statement, publishes notification of its availability, and comments on the adequacy and on the environmental acceptability of the proposed project. Identification of significant adverse project impacts may result in revisions to the plan, although CEQ has no authority to directly prevent implementation. CEQ has recourse to appeal to the President.

The EPA has its own regulations for preparing an EIS in compliance with NEPA and the CEQ guidelines. EPA regulations, published April 14, 1975 (EPA, April 1975) and approved by CEQ, apply to the presentation of the EIS for the City of Los Angeles' Facilities Plan.

b. Environmental Protection Agency. The Environmental Protection Agency (EPA) was established in the executive branch of the federal government as an independent Agency in December 1970. The EPA was created to "permit coordinated and effective governmental action to assure the protection of the environment by abating and controlling pollution on a systematic basis" (Environmental Protection Agency, February 1972).

The EPA sets and enforces environmental standards, conducts research on problems relating to environmental quality, and reviews state and local actions to implement federal programs administered by the EPA. There are ten Regional Administrators of the EPA responsible for coordinating and administering EPA programs in different parts of the country. California is in Region IX which has its headquarters in San Francisco.

Most of the major federal legislation relating to environmental quality is administered through the EPA. The EPA prepares regulations and guidelines for implementing the law and allocates federal money to programs mandated under the law. The Federal Water Pollution Control Act Amendments (FWPCA) of 1972 (PL 92-500) and the Clean Air Act of 1970 (PL 91-604) are the major federal laws which affect facilities planning. The EPA administers and reviews all facilities plans for which federal grant money is sought under Title II, Wastewater Treatment Works Construction Grants Program, of the FWPCA.

2. STATE AGENCIES

The primary California state agencies with regulatory authority that are responsible for water quality, air quality, and land use planning are the State Water Resources Control Board, the State Department of Health, the Air Resources Board, and the California Coastal Commission. The Office of Planning and Research is responsible for land use planning and environmental quality programs but has no regulatory authority.

a. California State Water Resources Control Board. The State Water Resources Control Board (SWRCB) was established in 1967 and placed within the State Resources Agency. SWRCB has nine Regional Water Quality Control Boards (RWQCBs). The State and Regional Boards implement the requirements of the Porter-Cologne Water Quality Control Act of 1969 (California Water Code, Division 7) and other portions of the California Water Code. SWRCB adopts policies and regulations relating to water quality. RWQCBs prepare regional goals, policies, and plans for major river basins.

b. California State Department of Health. The California State Department of Health is responsible for drinking water standards in the state. Chapter 7, Water Reclamation of Division 7 of the California Water Code (California Water Code, §13521), requires that the State Department of Health establish statewide reclamation criteria for the different possible uses of reclaimed water wherever public health might be affected. The Department's present position on reclaimed water uses involving domestic water supply calls for the final limitations on groundwater recharge with reclaimed water to be determined on a case-by-case consideration of scientific findings concerned with public health.

The Regional Water Quality Control Boards must consult with the Department of Health, and prescribed water reclamation requirements for any proposed uses of reclaimed water (California Water Code §13523). There may be no uses of reclaimed water until the Regional Board has either established requirements to protect public health or has determined that no requirements are necessary.

c. California Air Resources Board. The Air Resources Board (ARB) was created by the Mulford-Carrell Air Resources Act of 1967 in response to federal legislative initiative requiring the establishment of a single state agency concerned with air pollution control. The ARB, as part of the State Resources Agency, has responsibility for administration, research, development of standards, and coordination of air pollution activities; ARB is the designated state agency responsible for implementing the federal Clean Air Act. This requires establishing air quality standards at least as strict as federal requirements, and developing State Implementation Plans (SIP) for achieving and maintaining national air quality standards and goals as set forth by the EPA and the federal Clean Air Act. There is a SIP for each of the State's 11 air basins. Air Pollution Control Districts (APCDs) are charged with implementing the SIPs within air basins. Los Angeles is within the South Coast Air Basin and has been designated an Air Quality Maintenance Area (AQMA) because national air quality standards are not expected to be attainable before 1985. Because the South Coast Air Basin is an AQMA, the potential growth inducing impacts of the Facilities Plan are of particular interest to the ARB, and can be limited through legal requirements of state and federal financing provisions (see Sections IV.D and IV.E).

d. Califomia Coastal Commission. The California Coastal Zone Conservation Act of 1972 created the California Coastal Zone Conservation Commission (and six regional commissions) as a temporary agency charged with preparing a permanent coastal plan by December 1, 1975 and controlling coastal development for an interim period (California Public Resources Code, Sec. 27000 et seq.).

The coastal plan was submitted to the legislature on schedule and contained 162 policy statements in 443 pages. Legislation in the form of SB 1277 was then written to adopt major features of the plan and to create a permanent state-wide "California Coastal Commission" on January 1, 1977. This legislative act was approved by the Governor in September 1976, and is now primarily embodied in the Public Resources Code (Section 30000 et seq.).

Certain sections of this code refer to "Public Works," defined as including facilities for water and sewerage operated by a public agency, and "Treatment Works" as defined in the Federal Water Pollution Control Act (33 USC 1251 et seq.).

The coastal zone regulated by the commission extends seaward to the state's outer jurisdiction and inland 1,000 yards from the mean high tide line. Exceptions include several ecological bulges so that in significant estuarine habitats and recreational areas the zone may extend inland to the first major ridgeline paralleling the sea or 5 miles, whichever is less. In developed urban areas, however, the zone may be less than 1,000 yards.

Sections of this new law do apply to expanded wastewater facilities in the Los Angeles basin. For example the commission seeks to maintain and, where feasible, to restore biological productivity through minimizing adverse effects of wastewater discharges entrainment. The commission encourages wastewater reclamation (Pub. Res. Code 30231). Furthermore the new law added to the Water Code section 13142.5 which outlines the state's policy on water quality as it relates to the coastal marine environment.

> "(a) Wastewater discharges shall be treated to protect present future beneficial uses, and, where feasible, to restore past beneficial uses of receiving waters. Highest priority shall be given to improving or eliminating discharges that adversely affect any of the following:
>
> 1) Wetlands, estuaries, and other biologically sensitive sites.
>
> 2) Areas important for water contact sports.
>
> 3) Areas that produce shellfish for human consumption.
>
> 4) Ocean areas subject to massive waste discharge.
>
> Ocean chemistry and mixing processes, marine life conditions, other present or proposed outfalls in the vicinity, and relevant aspects of areawide waste treatment management plans and programs

but not of convenience to the discharger, shall for the purposes of this section, be considered in determining the effects of such discharges. Toxic and hard-to-treat substances should be pretreated at the source if such substances would be imcompatible with effective and economical treatment in municipal treatment plants."

"(b) Adequately treated reclaimed water should, where feasible, be made available to supplement existing surface and underground supplies and to assist in meeting future water requirements of the coastal zone, and that consideration, in statewide programs of financial assistance for water pollution or water quality control, shall be given to providing optimum water reclamation and use of reclaimed water."

While the primary responsibility for coordination and control of water quality remains with the State Water Resources Board, the coastal commission may review certain aspects of the development of the wastewater facility (Pub. Res. Code 30412).

In close consultation with the Water Resources Board the coastal commission must, by May 1, 1977, adopt regulations for the timing of its review of proposed "treatment works." (Pub. Res. Code 30338). This is in specific reference to section 30412 (c) which reads as follows: "Neither the commission nor any regional commission shall, except as provided in subdivision (c), modify, adopt conditions, or take any action in conflict with any determination by the State Water Resources Control Board or any California regional water quality control board in matters relating to water quality or the administration of water rights."

"(c) Any development within the coastal zone or outside the coastal zone which provides service to any area within the coastal zone that constitutes a treatment work shall be reviewed by the commission and any permit it issues, if any shall be determinative only with respect to the following aspects of such development:

1) The siting and visual appearance of treatment works within the coastal zone.

2) The geographic limits of service areas within the coastal zone which are to be served by particular treatment works and the timing of the use of capacity of treatment works for such service areas to allow for phasing of development and use of facilities consistent with this division.

3) Development projections which determine the sizing of treatment works for providing service within the coastal zone.

The commission shall determine whether the treatment works complies with the provisions of this division and shall make its final determination on a permit application for a treatment work prior to the final approval by the State Water Resources Control Board for the funding of such treatment works. Except as specifically provided in this subdivision, the decisions of the State Water Resources Control Board relative to the construction of treatment works shall be final and binding upon the commission and any regional commission."

"(d) The commission shall provide or require reservations of sites for the construction of treatment works and points of discharge within the coastal zone adequate for the protection of coastal resources consistent with the provisions of this division."

"(e) Nothing in this section shall require the State Water Resources Control Board to fund or certify for funding, any specific treatment works within the coastal zone or to prohibit the State Water Resources Control Board or any California regional water quality control board for requiring a higher degree of treatment at any existing treatment works."

Of further interest to decisionmakers in the Los Angeles Basin is the new Public Resources Code (section 30605) which permits a procedural alternative to project-by-project review in order to promote greater efficiency in planning long range land use development for public works in the coastal zone.

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The Coastal Commission reviews the visual aspects of treatment works within the coastal zone.

e. California Office of Planning and Research. The Office of Planning and Research (OPR) was created in 1970 to operate within the Governor's Office and to assume responsibility for comprehensive land use and environmental policy planning. OPR is specifically designated to take "primary responsibility for assuring orderly operation of the process of environmental policy development and implementation within state government" (Gov't Code §65035). However OPR has no implementation authority. OPR prepared the guidelines for implementing the California Environmental Quality Act (CEQA) of 1970 (Public Resources Code §21000 et seq.) which requires an Environmental Impact Report (EIR) on both governmental activities and private activities requiring governmental approval that have a significant effect on the environment. OPR does not have authority over the implementation of proposed projects, and neither CEQA nor the guidelines clearly require reviewing agencies to reject projects found to have serious adverse impacts on the environment. However, there are court cases indicating that a reviewing agency may force selection of a project alternative to mitigate adverse project impacts.

3. REGIONAL AND LOCAL AGENCIES

Regional agencies are those governmental bodies whose authority or representation covers more than one political entity at a given level—for example, more than one county, or more than one city. Most regional agencies are designated through a state authority in order to plan, coordinate, and implement programs that are responsive to a regional need. Local agencies are multipurpose political entities, such as the City of Los Angeles, or special purpose entities such as districts.

a. Southern California Association of Governments. The Southern California Association of Governments (SCAG) was established in 1965 by Joint Powers Agreement and covers Imperial, Los Angeles, Orange, Riverside, San Bernardino, and Ventura Counties. The 18-member Executive Committee from each county, one delegate from a city in each county, and three at-large delegates is the main decisionmaking body of SCAG. The membership of municipalities is SCAG is voluntary.

SCAG is the lead agency responsible for coordinating housing, land use, transportation, utilities, and flood control planning in the six county area. SCAG is officially responsible for federal housing and transportation planning programs, and is the designated metropolitan clearinghouse for grant reviews and environmental impact reviews. SCAG has also generated growth forecasts predicting the future distribution of population within the regional area. SCAG will review the City of Los Angeles' Facilties Plan EIS for consistency with regional population projections and plans.

b. Southern California Air Pollution Control District and South Coast Air Quality Management District. The air pollution control districts of four counties—Los Angeles, Orange, Riverside, and San Bernardino—have been combined by the formation of the Southern California Air Pollution Control District (SC-APCD). Between July 1, 1975 and July 1, 1976, the agency was in a transition period to provide for integration of the four former single county APCDs (Southern California Air Pollution Control District, 1975).

The SC-APCD currently has the primary responsibility for issuing permits for new stationary sources but if it fails to implement the State Implementation Plan (see Section IV.B.2c) for achieving and maintaining applicable air quality standards, the responsibility falls back to the ARB or eventually to the EPA at the federal level. On July 2, 1976, the Governor signed Assembly Bill No. 250 which establishes the South Coast Air Quality Management District (SC-AQMD) to commence operations February 1, 1977. The SC-AQMD assumes the role of the SC-APCD, has authority in the same area, and is required to employ the former staff of SC-APCD. An air quality management plan must be adopted by SC-AQMD by January 31, 1979 and approved by ARB by June 1, 1979. The Air Quality Maintenance Plan Policy Task Force of the South Coast Air Basin is currently involved in developing mechanisms and procedure for air quality planning in the basin. The Policy Task Force members and their preliminary planning work will contribute to the new plan.

Stationary source permits issued in the Los Angeles waste treatment facilities service area will influence the number and character of treatment facility users entering the service area. Similarly, the Facilities Plan may have the potential for growth inducing impacts which could contribute to air quality problems and which would therefore be of concern to the ARB and its regional district.

c. Regional Water Quality Control Board, Los Angeles Region. Regional Water Quality Control Boards (RWQCBs) were established in section 13200 of the State Water Code. The RWQCB, Los Angeles Region, has jurisdiction over the Los Angeles and Santa Clara River Basins, and has prepared separate water quality control plans for each of these basins in accordance with the provisions of the California Water Code. The Basin Plan for the Los Angeles River Basin has been adopted by SWRCB, and after approval by the Regional Administrator of the EPA, will fulfill the federal requirements of PL 92-500 for state approved basinwide planning of water pollution control efforts. In order to qualify for state and federal financing, the City of Los Angeles' Facilities Plan must be consistent with the guidelines and specific regulations in the Water Quality Control Plan Report, Los Angeles River Basin (RWQCB, Los Angeles Region, 1975). The RWQCB also issues the waste discharge permits that must be obtained for operation of the waste treatment facilities.

d. Los Angeles County Department of Regional Planning. The Los Angeles County Department of Regional Planning is responsible for preparing a comprehensive general plan for the County that will serve as a basis for zoning and land use decisions in unincorporated portions of the County. The Department also reviews all projects which have significant potential impact on the County. Although there is currently no approved comprehensive county plan, the Department will review the Los Angeles Facilities Plan and the County's comments will be submitted to SCAG.

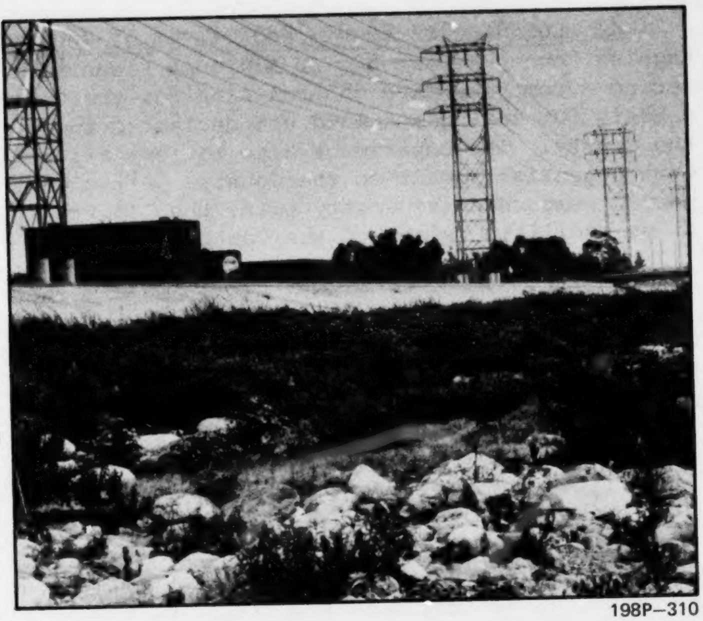
e. City of Los Angeles. The City Council is the final City authority with respect to most city projects. The Council must adopt the Facilities Plan and its recommendations before it can become the official position of the City.

(1) BUREAU OF ENGINEERING. The Bureau of Engineering, under the Department of Public Works, is headed by the City Engineer and is directly responsible for public works facilities planning. The planning team functions within the Bureau's Wastewater Systems Engineering Division and consists of professionals in the fields of wastewater treatment, hydraulics, and environmental impacts.

In June, July, August, and October of 1975, the Bureau submitted portions of the Wastewater Facilities Plan to the State Water Resources Control Board and the federal Environmental Protection Agency for their initial review and comments. A preliminary Final Draft of the Plan was prepared by the City in December 1975; however, revision in proposed alternatives based on revised population estimates is currently under way. A series of five public meetings was held to provide for input from the affected residents.

The focal point for City governmental activities is City Hall in downtown Los Angeles.

The Department of Water and Power is responsible for providing water to meet the needs of all Los Angeles City residents.



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(2) DEPARTMENT OF WATER AND POWER. The Department of Water and Power (DWP) is assigned the duty of supplying the City and its inhabitants with water and electric energy, and is empowered by the City Charter to regulate and control the use, sale, and distribution of water and electric energy owned or controlled by the City. The approval of the City Council and Mayor are not required for DWP to carry out most of its duties.

DWP supplies water to most of the Facilities Plan service area. The water supply affects the Facilities Plan because the source and treatment of water supplied to the City partially determine the mineral content and other characteristics of wastewater entering the treatment facilities. Also, the cost of water affects the volume of effluents to be treated. If the adopted Facilities Plan provides for water reclamation, this supply could be managed through DWP.

(3) DEPARTMENT OF CITY PLANNING. The Department of City Planning is responsible for preparing a General Plan for the City which is a comprehensive declaration of purposes, policies, and programs for the development of the City. The Plan must be adopted by the City Council as a whole or in part by geographic areas or subject elements.

The Department prepares population projections which influence the extent of future facilities planning. The Department has also undertaken several special studies which involve master plans for industrial and commercial systems, water supply and sewage systems, and existing and future land use (Department of Public Works, December, 1975).

f. Inter-City Sewage Disposal Agreements. The City of Los Angeles presently has contractual arrangements for the transport, treatment, and disposal of sewage with more than 30 separate entities. These include 7 neighboring cities, 7 County Sanitation Districts, and numerous diverse small units, both public and private, such as a federal office building, Barrington Post Office, a National Guard Armory, and Hughes Tool Company.

Contractual agreements with neighboring cities are long-standing and in some instances can be traced back for more than 50 years (e.g., Glendale since 1923). These agreements reflect the increasing complexity of wastewater transport and treatment as the population and demands on the system rapidly grew. Each contracting city has entered into agreements with the City of Los Angeles under situations which differ in time and complexity and with problems and conditions specific to each locality. These separate, distinct, and sometimes unique contractual arrangements require individual attention by the City of Los Angeles including monitoring the quantity and quality of the effluent, assessing charges that are computed on different bases, and managing the operational and technical aspects of the sewage discharged into the system by these different contracting entities. A pattern of basic agreements common to the major users of the wastewater system does not exist, and because of the nature of the present contracts it cannot be easily achieved.

Such a basic contract, common to the several municipalities and County Sanitation Districts and uniform in terms of agreement to a limited period of years would increase efficiency, lower costs, and greatly simplify the operations now under contract with the City of Los Angeles for the transport, treatment, and disposal of sewage. An analysis of the present contracts fails to disclose elements in common sufficient to attain such a basic agreement in the near future, but certain aspects of the existing arrangements are prominent and can be generally described. Table IV-1 summarizes the current status of the contractual agreements.

For most of the major users of the system, the term of their present agreement continues for the useful life of the sewerage facility, including any extension of useful life derived through maintenance, repair, or improvement. Other contracts extend for an indefinite or undefined period and some small ones continue until revoked by the Los Angeles City Council. Until a situation occurs which makes renegotiations of a contract attractive to a major user, an amendment of the term of agreement to a fixed number of years is difficult to arrange.

The average flow in the Hyperion Treatment Plan allocated to a contracting party is directly influenced by and dependent upon the capacity of that plant. For example, Table IV-1 identifies the permitted flow in Hyperion as allocated to Glendale to be "an Average Flow of 19.15 mgd or 19.15/420ths of the Average Flow through the plant, whichever is greater, unless the Average Flow capacity of the plant is determined to be less than 420 mgd." In that situation, the Glendale allocation would be 19.15/420ths of the lesser capacity of the plant, whatever it is determined to be. A reduction in the capacity of the Hyperion Plant, for

Table IV-1. Major sewer disposal agreements with City of Los Angeles.

ORDER OF RANK	CONTRACTING PARTY	AGREEMENT REFERENCE	TERM OF CONTRACT	FLOW RIGHTS		IF HYPERION CAPACITY LESS THAN 420 MGD	CHARGE RATES (1974-75)		CAPACITY RIGHTS PURCHASED SINCE 1960 # EARLIER PURCHASES	AVG. DAILY FLOW 1974-75 (MGD)	RECOURSE FOR NON-COMPLIANCE	STATUS OF REVISIONS
				HYPERION MGD AVE.*	SEWER CFS PEAK**		TREATMENT ($/mg)	CONVEYANCE ($/mg)				
1	Glendale	2/21/64	Useful Life of Facilities	19.15	37.0	$\frac{19.15}{420}$ X Lower capacity	39.6497	0.5502	7.15 mgd HTP 10.5 cfs pk. 10.0 mgd LAGWRP	16.0	Adm. Arbit.	May lose 1/4 HTP capacity if to 307 mgd
2	Santa Monica	2/21/64	Useful Life of Facilities	11.00	35.2	$\frac{11.00}{420}$ X Lower capacity	39.6497	25.0665	1.31 mgd HTP 13.77 cfs	11.1	A.A.	May lose 1/4 HTP capacity if to 307 mgd
3	Burbank	4/46	Useful Life of Facilities	10.0	11.5	Reneg. if state revokes present Hyperion discharge permit	50.3124	0.2508	#	6.8	Court	To be renegotiated for 307 cap.
4	Beverly Hills	11/10/65	Useful Life of Facilities	7.26	21.57	$\frac{7.2610}{420}$ X Lower capacity	39.6497	0.1221	3.25 mgd HTP 9.07 cfs pk.	6.1	A.A.	May lose 1/4 HTP capacity if to 307 mgd
5	Culver City	12/31/51	Indefinite Period	6.71	10.38	No Change	50.3124	1.8058	#	4.5	Court	Requested add'l capacity
6	County Sanit. District #4	9/30/65	Useful Life of Facilities	6.60	19.31	$\frac{6.60}{420}$ X Lower capacity	39.6497	0.1082	4.31 mgd HTP 11.92 cfs pk.	4.5	A.A.	May lose 1/4 HTP capacity if to 307 mgd
7	Marina del Rey	10/24/66	Useful Life of Facilities	3.00	9.00	0.97 mgd purchased 2.03 Conditionally rented	49.1080	6.9495	0.18 mgd HTP 0.52 cfs pk.	3.2	Court	None envisioned
8	El Segundo	11/18/60	Useful Life of Facilities	2.75	7.00	No Change	49.1080	------	1.55 mgd HTP 4.00 cfs pk.	1.9	Court	None envisioned
9	San Fernando	1/30/50	Useful Life of Facilities	1.14	3.2	No Change	50.3124	4.8417	#	1.6	Court	In process

* By comparison with "Avg. Daily Flow 1974-75" column, an indication can be obtained of the proximity of current avg. flow to permitted avg. flow. San Fernando negotiations are underway; Santa Monica and Marina del Rey are renting excess capacity.

** Current peak flow calculations are not routinely made unless agency appears to be approaching or exceeding its rights. Only Marina del Rey currently falls into this category.

example, to accommodate full secondary treatment, would have a significant effect on the actual amounts of contractually permitted flows of some of the present users. The allocation of existing flows to La Cienega could bring into question the existing contractual arrangements tied to Hyperion and force a renegotiation of the contractual agreements or litigation or both.

Some of the major contracts also have allocations of peak flow capacity defined as the maximum instantaneous dry weather discharge of sewage expressed in cfs. Some of the contracting cities have acquired ownership of certain capacity rights in the sewers which they are using. These vary among the contracting parties and further complicate the pattern of agreements. When the flow of sewage reaches 95 percent of the amount permitted by the contract,the parties may be required to negotiate an amendment.

Charges are not uniform; some smaller units are on a fixed, flat annual basis. Larger users are assessed for treatment and transportation on the basis of a charge per million gallon units contributed to the system. The rate charged differs between contracts. This is caused in part by different agreements on overhead rates of payment. If the City of Los Angeles cannot grant a request of a contracting party to purchase additional permitted flow capacity it may "rent" such capacity to the party.

The rental charges are determined annually. If a contracting party discharges a flow in excess of the agreed capacity, including rented capacity, an excess flow charge is levied. This is based on a percentage of unit capital costs per mgd of the Hyperion Plant and its improvement and on a percentage of the unit capital costs per cfs of the particular sewers being used. The excess flow charge increases in consecutive years. For example, the excess flow charges specified in the Glendale contract are 10 percent of the capital costs for the first year, and these increase at the rate of 1 percent each consecutive year until they reach 14 percent in the fifth year and each year thereafter. If a contracting city continued to discharge excess flows, and thereby incurred annually increasing penalty charges, it might find a renegotiation of the contract an attractive option.

There are provisions in the agreements for the enforcement of regulations on quality standards. These also permit the City of Los Angeles to force contracting parties to comply with new or revised standards as they may be adopted by the City of Los Angeles.

In many, but not all, of the contracts there is a provision for administrative arbitration of disputes. If either party in good faith refuses to accept the decisions of the arbitrators, legal action may follow but the decision is mutually offered as admissible evidence in court.

C. water quality controls and planning

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C. WATER QUALITY CONTROLS AND PLANNING

1. FEDERAL WATER QUALITY CONTROL PLANS AND REGULATIONS

The U.S. Environmental Protection Agency (EPA) is responsible for setting and enforcing most of the federal regulations affecting water quality. The most important legislation specifying this authority is PL 92-500, the Federal Water Pollution Control Act Amendments of 1972 (FWPCA), which covers a variety of programs designed to improve the quality of the nation's waters. The emphasis is on planning and regulation of discharges. The L.A. Facilities Plan is directly affected by these regulations because of the Act's restrictions on municipal treatment plant planning and discharges, and because pretreatment standards and land use planning affect the volume and character of the wastes entering the public treatment facilities.

Drinking water regulations affect planning for wastewater treatment facilities because of the potential for water reuse, and the difficulties and costs associated with adequately pretreating contaminated water supplies that are to be used for human consumption. Standards for drinking water are promulgated and implemented by the EPA through the authority of the Public Health Service Act as amended by PL 93-523, the Safe Drinking Water Act. Extensive interim drinking water regulations have been published but are still undergoing revision and have not been fully implemented.

a. Federal Water Pollution Control Act. The FWPCA Amendments of 1972 set federal requirements for controlling water pollution. The overall objective of PL 92-500 is to "restore and maintain the chemical, physical and biological integrity of the Nation's Waters" (section 101 (a)). The five major sections (titles) of PL 92-500 cover research, financing, planning, standards, permits, enforcement, and other related aspects of a comprehensive program to control water pollution. Title I outlines the goals of the Act and requires the EPA to develop comprehensive programs for improving water quality by cooperating with, and providing some funding to state and local agencies. Industries and other federal agencies may also be involved.

Title II covers grants for construction of treatment facilities. Federal funding of publicly owned treatment works is set at 75 percent of the cost of construction. Section 201 planning, or facilities planning,

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must consider (a) areawide or regional control of point and nonpoint sources, (b) construction of revenue producing facilities, (c) integration of municipal and industrial treatment and recycling systems, and (d) plans which combine open space and recreational opportunities with waste treatment management (Section 201c-f). It is further required that facilities receiving federal funding conform to areawide waste treatment management plans (Section 208 planning) and basin plans (Section 303 [e] planning). Title II also outlines the requirements for areawide, or 208 planning, which is in the process of being carried out in the Los Angeles Basin.

Title III covers standards and enforcement for wastewater discharges and provides for State level river basin, or 303 (e) planning. Effluent limitations on publicly owned treatment works require secondary treatment by July 1, 1977, and best practicable waste treatment technology by July 1, 1983 (Section 301). Discharge of warfare agents and of high level radioactive wastes is prohibited. Specific limitations on the effluents from new industrial sources are currently being developed by EPA according to the requirements of Title III. Similarly, pretreatment of industrial wastes is being required for pollutants which interfere with, or are not adequately controlled by publicly owned treatment facilities.

Title IV provides for a permit or license system for all discharges to navigable waters (broadly defined to include almost all U.S. surface waters and coastal waters). The national pollutant discharge elimination system (NPDES) provided for in Section 402 of PL 92-500 is implemented through the states if and only if, EPA approves the State's implementation and enforcement mechanisms.

Title V of PL 92-500 includes general provisions not specifically affecting facilities planning. Portions of the Act most directly related to facilities planning are discussed in greater detail in the following sections. In addition to the regulations currently in effect, the EPA is continuing to issue the regulations authorized by PL 92-500 and to update those already issued.

(1) PLANNING FUNCTIONS OF PL 92-500: 201, 208, AND 303 (e) PLANNING. Facilities planning (201) areawide wastewater treatment management planning (208), and basin planning (303 [e]) are the three levels of planning effort provided for in PL 92-500. The first is the most localized and is directed toward construction of specific facilities to improve water quality. The second is areawide, usually including several 201 planning areas, and is directed toward management and planning that will control nonpoint sources as well as point sources of pollution. The third, basin planning, covers broad geographical areas and emphasizes coordination and centralization of water quality management decisions.

The 303 (e) planning process must include (a) schedules of compliance with effluent limitations, (b) applicable areawide plans prepared under Sections 201 and 208, (c) total maximum daily loads of pollutants for water quality class stream segments, (d) procedures for plan revisions,

(e) authority for inter-governmental cooperation, (f) provisions for adequate implementation of the plan, (g) controls for disposition of water processing residual stream, and (h) an inventory and ranking in order of priority of facility needs. The basin plan assesses for the entire river basin the nature and extent of water pollution in order to develop a strategy for bringing substandard waters up to water quality standards and to prevent the degradation of high quality waters. From this assessment, the allowable volume of pollutants which can be discharged into each stream segment is determined. These volumes are allocated to each point source using the discharge permit system.

Based on instream water quality, a segment is classified either as an effluent limited segment or a water quality limited segment. An effluent limited segment is one in which water quality will meet, and continue to meet, all applicable water quality standards after the application of minimum national effluent limitations established by the EPA for point-source discharges and municipal treatment works. A water quality limited segment is one in which water quality will meet applicable standards only after achievement of more stringent effluent limitations (EPA, 1975a).

Based on the assessment of problems and causes, each stream segment is ranked in an order of priority. The priorities established in the basin planning process are used to determine allocation of funds and enforcement efforts directed toward water quality improvement.

States are charged with carrying out basin planning. The governor of each state must submit the state's continuing planning process for basin planning to the EPA Regional Administrator for approval. Within 30 days, the Administrator notifies the governor of approval or disapproval with any necessary revisions. Approval of a state's continuing planning process may be withdrawn based on gross failure to comply with the schedule for basin plan preparation, or failure for basin plans to conform with process requirements.

Since areawide waste treatment (or 208) planning is carried out within the boundaries of a river basin, the 208 planning process must conform to the management strategy and constraints of the basin plan. Appropriately, SCAG has assumed these 208 responsibilities. Areawide planning is generally confined to those areas of the basin or basins where complex urban/industrial point sources or nonpoint sources cause water quality problems that cannot be solved by base level or secondary treatment alone. The 208 program stresses planning by local governments in finding and implementing solutions to mutual water quality management problems. It calls for a special management structure to carry out the planning, and provides grants to help local governments cover their planning costs. Areawide planning incorporates a permit system for municipal and industrial discharges, deals with urban and other nonpoint pollution sources, and integrates the water quality management program with other environmental and development activities such as air quality and solid waste management (EPA, 1975a). Such areawide planning considers land use and development in both the public and private sectors.

Areawide planning expands the scope of a facilities plan in including one or more 201 facilities planning area(s). The areawide approach builds upon the contents of completed facilities plans and directs the course of future facilities plans. By dealing with such related issues as land use, development, and the combined effects of all the treatment plans within its planning area, the 208 plan permits a comprehensive view of the water quality problem and its possible solutions (EPA, 1974).

Facilities planning, or 201 planning, is carried out by regional or local agencies, frequently the municipality that will own and operate the proposed facility. Publicly owned wastewater treatment facilities meeting the requirements of PL 92-500 may receive 75 percent financing by the federal government in a three-step grant program. Step 1 is in the planning phase, including preparation of an Environmental Impact Statement fulfilling the requirements of NEPA. Step 2 grants fund the preparation of engineering specifications, operation and maintenance manuals, and related details plans. Step 3 grants apply to construction costs.

Facilities planning (Step 1) must include the objective of providing secondary treatment and must meet all applicable effluent standards and water quality criteria. The planning process is to be carried out in the following twelve phases:

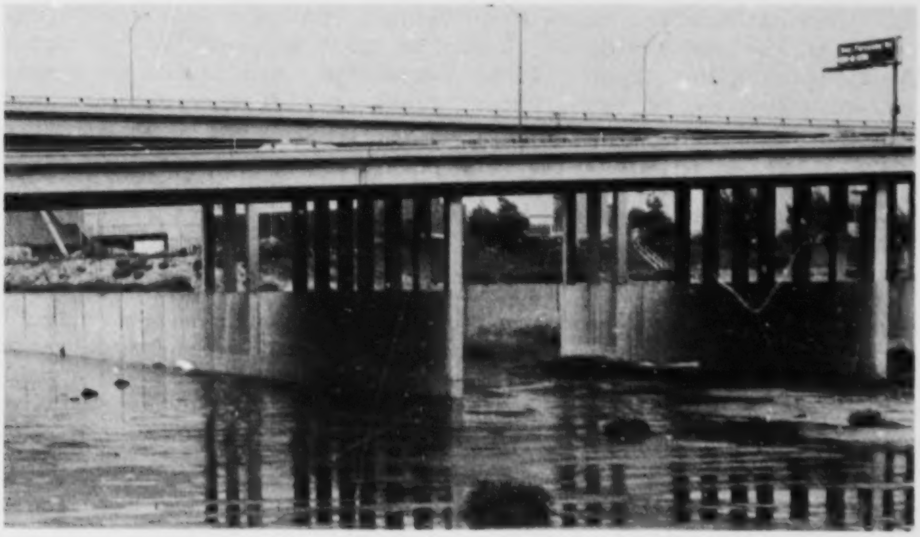
1. Delineate planning areas
2. Prepare a plan of study
3. Establish water quality objectives and other water management goals
4. Review pollution source waste loads and water quality information
5. Inventory existing waste treatment systems and determine existing flows
6. Inventory environmental conditions
7. Estimate future waste solids and flows
8. Develop and evaluate alternatives
9. Evalute implementation arrangement
10. Refine, review, and display alternative proposals
11. Select plan
12. Complete implementation arrangements (Bureau of Engineering, Department of Public Works, 1975).

Facility plans must conform to approved basin plans (303 [e]), and be compatible with ongoing areawide waste treatment management plans (208) where the interim outputs of the 208 plan have been approved at state and federal levels.

(2) INDUSTRIAL PRETREATMENT STANDARDS. The Federal Water Pollution Control Act Amendments of 1972 require EPA to develop effluent limitations for point sources of pollution, and permit states to develop more stringent limitations than those of EPA. The statute authorizes a series of steps to be taken to achieve the goal of eliminating all discharges of pollutants into the nation's waters by 1985 (Section 101[a][1]).

The EPA has promulgated industrywide regulations imposing three sets of precise limitations on discharges. The first two impose progressively higher levels of pollutant control on existing point sources after July 1, 1977, and after July 1, 1983, respectively. The third set imposes limits on "new sources" that may be constructed in the future. (A point source is defined as "any discernible, confined and discrete conveyance,. . . from which pollutants are or may be discharged," Section 502.)

Section 301(b) of the Act defines the effluent limitations that shall be achieved by existing point sources in two stages. By July 1, 1977, the effluent limitations shall require the application of the best practicable control technology currently available; by July 1, 1983, the limitations shall require application of the best available technology economically achievable. These terms are defined in Section 304 which is a section that requires the publication of "regulations providing guidelines for effluent limitations." In compliance with the Act, EPA has issued at least 42 separate effluent guidelines for various industries (e.g., 40 CFR 405-460 not in sequence). EPA's authority to issue uniform industrywide regulations has been challenged, but the U.S. Supreme Court



Industrial discharges into the municipal system or receiving waters is required to be in compliance with federal industrial pretreatment and effluent standards.

in the case of Dupont v. Train decided on February 23, 1977 that EPA has the authority to promulgate by regulation uniform, industrywide effluent limitations for existing sources of water pollution.

(3) TOXIC EFFLUENT STANDARDS. Recently EPA has issued certain toxic pollutant effluent standards (40 CFR 129) and is in the process of developing additional ones in accordance with a schedule for final promulgation by December 1979.

(4) SECONDARY TREATMENT INFORMATION. Secondary treatment by July 1, 1977, is required at all publicly owned treatment works according to Section 301 of PL 92-500.

(5) OCEAN DUMPING. Final regulations for ocean dumping are now in 40 CFR 220-229 (Fed. Reg. January 11, 1977). Regulations for ocean discharge from a pipe will be repromulgated in the future as 40 CFR 231. Previously 40 CFR 227 contained criteria for the evaluation of permit applications for ocean dumping, including discharges through outfalls, but this section has been suspended (Fed. Reg. Jan. 11, 1977).

(6) ALTERNATIVE WASTE MANAGEMENT TECHNIQUES. Starting with funds for fiscal year 1975, the EPA must require 201 grant applicants to demonstrate that alternative waste management techniques were evaluated. Pursuant to Section 304(d) of PL 92-500, the EPA published, on October 17, 1975, a report (EPA, October 1975) containing information on three major alternative management techniques. These are (1) alternatives employing treatment and discharge, (2) alternatives employing land application and utilization practices, and (3) alternatives employing reuse. Each of these alternatives must be evaluated by construction grant applicants and the most cost-effective method which meets specific criteria must be selected.

The criteria for treatment and discharge to navigable waters must, at a minimum, meet the standards for secondary treatment (see Section IV.C.1). Groundwater resulting from or affected by land application, and effluents from a reuse project which are attributable to a publicly owned treatment works, must meet differing portions of the requirements for drinking water supply systems depending on the present and potential use of the groundwater.

In Case 1, where the groundwater can potentially be used as drinking water supply, the levels of organic and inorganic chemicals are regulated. Case 2, where the groundwater is used as a drinking water supply, microbial contamination limits apply in addition to the criteria for Case 1. Case 3 applies to uses other than drinking water, and criteria are to be established by the Regional EPA Administrator based on present or potential use of the water. In all cases, monitoring is required, and irrevocable damage to the groundwater is prohibited.

(7) NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES). The major tool for enforcement of effluent standards and limitations and water quality standards is through use of the national pollutant discharge elimination system (NPDES) permit program. Section 402 of PL 92-500 gives EPA the authority to issue condition and deny permits for all point source discharges to navigable waters and the oceans. The permit system also applies to the disposal of sewage sludge where any pollutant from the sludge would enter navigable waters. EPA's regulations on policies and procedures for the NPDES are given in 40 CFR 125.

Permits must include a detailed quantitative listing of the pollutants to be discharged, and must provide a schedule of compliance for meeting the applicable effluent objectives of best practicable waste treatment methods and best available methods. Permits must cover all applicable effluent standards and limitations, water quality standards, and certain more stringent requirements legally applicable. Where any pollutant to be discharged is not in compliance with applicable regulations, the applicant must outline and follow specific steps to achieve compliance. Certain discharges are prohibited so that permits for them cannot be issued. This category includes any discharge from a point source which is in conflict with an approved 208 plan.

The EPA has established a program to delegate the NPDES permit authority to the individual states. Implementation and enforcement policies of responsible state agencies must be approved by the EPA, and EPA retains certain rights to deny or modify permits. EPA regulations on State program elements necessary for participation in the NPDES are covered in 40 CFR 124.

b. Safe Drinking Water Act. The Public Health Service Act as amended by the Safe Drinking Water Act (PL 93-523) authorizes the Environmental Protection Agency to establish national drinking water regulations and to provide for their enforcement. Through the regulations new technology and information, as they become available, can be incorporated into national policy to provide dependable sources of safe drinking water. The regulations include definitions of maximum contaminant levels, procedures for water quality control and testing, and criteria for the siting of new public water facilities. The maximum contaminant levels cover inorganic chemicals, organic chemicals, turbidity, and microbes. All of these limitations, with the exception of turbidity, apply to facilities planning because they are included in the criteria limiting groundwater contamination from land application and wastewater reuse according to EPA regulations on alternative waste management techniques (see Section IV.C.1a[6]). On December 24, 1975, EPA promulgated the National Interim Primary Drinking Water Regulations (EPA, December 1975)which, with revisions, will become effective June 6, 1977.

2. CALIFORNIA STATE WATER QUALITY CONTROL PLANS AND REGULATIONS

In California, the requirements of the Federal Water Pollution Control Act Amendments of 1972 (PL 92-500) are implemented through the Porter Cologne Water Quality Control Act (Division 7 of the California Water Code). This act allows for the regulation of activities and factors which may affect the quality of California's waters. The general goal is "to attain the highest water quality which is reasonable, considering all demands being made and to be made on (State) waters and the total values involved, beneficial and detrimental, economic and social, tangible and intangible" (California Water Code §13000).

a. Activities and Requirements of the State Water Resources Control Board. The State Water Resources Control Board (State Board) and the nine Regional Water Quality Control Boards (Regional Boards) were established by the Porter-Cologne Act, to be responsible for the coordination and control of water quality. The State Board acts as the State water pollution control agency for the purposes stated in PL 92-500. It formulates and adopts state water quality policies, and it coordinates Regional Boards, approves plans and allocates state and federal funds. Essentially all of the federal programs and regulations relating to water quality are coordinated or implemented at the state level in California through the State Water Resources Control Board and the applicable Regional Board. The State Board administers federal programs for financial assistance, including 201 grants; designates 208 regions and approves plans; approves 303 (e) plans prepared by Regional Boards; and issues permits in fulfillment of NPDES requirements.

The Regional Boards develop and administer water quality control plans, or basin plans, at the regional level. These plans must reflect state and federal objectives, but within the framework each region may establish its own water quality objectives. The water quality control plans of each region, after approval and adoption by State Water Resources Control Board, become part of the California Water Plan as provided for in Division 6 of the California Water Code. After federal approval, the regional plans pertaining to the appropriate river basins, fulfill the federal requirements for basin planning as specified in Section 303 (e) of PL 92-500. Facilities plans (201) and other water quality planning within a river basin must conform to the goals and requirements of the approved basin plan.

Regional water quality control plans (basin plans) incorporate all State Water Resource Control Board policy which is applicable to the region. Plans adopted by the State Board which significantly affect the regional plans include the Water Quality Control Plan for Ocean Waters of California (the "Ocean Plan")(SWRCB, July 1972a), the Water Quality Control Plan for Control of Temperature in the Coastal and Interstate Waters and Enclosed Bays and Estuaries in California (the "Thermal Plan") (SWRCB, May 1972), the Water Quality Control Policy for the Enclosed

Bays and Estuaries of California (the "Enclosed Bays and Estuaries Plan") (SWRCB, May 1974), the State Policy for Water Quality Control (SWRCB, July 1972b), the Statement of Policy with Respect to Maintaining High Quality of Waters in California and various other guidelines and agreements.

The Ocean Plan was adopted by the State Board on July 6, 1972 (Resolution No. 72-45). The plan sets limits for the discharge of wastes to the ocean with the goal of protecting the beneficial uses of ocean water. Bacteriological, physical, chemical, biological, toxicity and radioactivity standards are set and the management principles given include specific effluent limitations (see Section IV.B.6b[2]). The discharge of hazardous substances and sludge, and the bypassing of untreated waste to the ocean are prohibited. Areas of special biological significance, as determined by the Regional Board according to the State Board guidelines, are to be protected from any change in natural water quality conditions.

The Thermal Plan first was adopted by the State Board on January 7, 1971, and was revised October 13, 1971, June 5, 1972, and September 18, 1975. The plan specifies the thermal limits for effluents to cold interstate waters, warm interstate waters, coastal waters, enclosed bays, and estuaries. The intent of the plan is to preserve beneficial uses of receiving waters, and the 1975 revision to the plan permits imposition of additional limitations to meet this goal. Also, the revision requires monitoring of discharges and permits independent monitoring with financing by the discharger required.

The Enclosed Bays and Estuaries Plan was adopted by the State Board on May 16, 1974 (Resolution No. 74-43). The plan is intended to provide guidelines for protecting the beneficial uses of the waters of enclosed bays and estuaries. The main policy of the plan is to phase out all municipal wastewaters and industrial process water discharges (except cooling water discharges) to enclosed bays and estuaries (except the San Francisco Bay-Delta system) unless it can be shown that the discharge would enhance the quality of the receiving water more than the quality would be enhanced by no discharge. Prohibitions or limitations are placed on the discharge of wastes from new municipal or industrial sources, thermal wastes, radioactive wastes, dredge spoil disposal, toxic substances, sludge, rubbish, untreated waste, silt, etc., petroleum products, and warfare agents. Monitoring is required.

The State Board continues to adopt resolutions which bring California's water quality control program into compliance new regulations promulgated by the EPA according to the authority of PL 92-500. Many of the existing state regulations, particularly with respect to ocean discharges, are more strict than the corresponding federal regulations.

The NPDES permit authority is vested for California, with the State and Regional Boards as "waste discharge requirements" or WDRs, as described in the Porter-Cologne Water Quality Control Act. The boards may issue permits after proper notice and hearing as described in state and federal law.

b. Activities and Requirements of the State Department of Health. In California the State Department of Health is responsible for drinking water standards and advises Regional Boards on aspects of basin plans and facilities plans dealing with water reuse. The state requirements for drinking water must be at least as stringent as federal requirements authorized in PL 93-523 and described in subsequent regulations. Drinking water standards apply to facilities planning because of the potential effect of alternative wastewater management techniques on existing or potential drinking water supplies. The water quality criteria used to evaluate "best practicable" waste treatment technology are the same criteria used for drinking water as established in the National Interim Primary Drinking Water Regulations (EPA, December 1975). Further, any amendments to the drinking water regulations will automatically apply to the criteria for evaluating alternative waste treatment methods.

Noningestive uses of treated wastewater for landscape irrigation, industrial use, and release to restricted and nonrestricted waterways are acceptable to the Department of Health, provided that treatment levels are adequate. Criteria and general design requirements for systems giving the necessary levels of treatment are included in "Wastewater Reclamation Criteria" (California Administrative Code, Title 22, Division 4). At this time the California State Department of Health has not endorsed any ingestive uses of reclaimed water, either direct or indirect, through recharge of domestic waters aquifers. The Department of Health's objections to reclaimed water entering the domestic water system are based chiefly on the presence of organic residues in treated wastewater.

As stated by the California State Department of Health (1973), in a paper entitled "Position on Basin Plan Proposals for Reclaimed Water Uses Involving Ingestion":

> This is an area of unknowns—unknowns involving the composition of the organic materials, the types of long-term effects, synergistic effects, metabolite formations, treatment effects, methods of detection and identification, and ultimately, the levels at which long-term health effects are exerted.

The paper sets forth "guidelines for Department of Health review and recommendations on basin plan reclamation components that involve augmentation of a domestic water supply." Three possible "ingestive" uses of reclaimed water are considered in the paper:

1. Groundwater recharge by surface spreading
2. Direct injection into an aquifer suitable for use as a domestic water source
3. Direct discharge of reclaimed water for supply augmentation into a domestic water system or storage facility

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The California State Department of Health sets standards for drinking water that recognize the potential effect of wastewater treatment technology on drinking water supplies.

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Water flowing in the unlined portion of the Los Angeles River recharges groundwater in the Los Angeles Narrows area. The unlined portion ends to the right of the photo near the Golden State Freeway.

The first two uses are considered in the Los Angeles Facility Plan. The State Department of Health's position on groundwater recharge with reclaimed water as discussed in the paper depends on "treatment, changes or removals which occur during percolation, dilution and time." The Department notes that "Surface spreading appears to have the greatest potential for use of reclaimed water in the basin plans," because spreading and subsequent filtration through the soil layers probably provide for effective removal of bacteria and viruses. However, due to the uncertainties described previously the Department will recommend against "near-term proposals which involve the recharge of a substantial volume of reclaimed water into a small basin" (California State Department of Health, 1973).

The Department of Health, on the basis of this policy, has expressed opposition to the near-term use of a treated wastewater from the Sepulveda Facility for infiltration into the groundwater basin through the Headworks Spreading Grounds operated by the Department of Water and Power (California State Department of Health, 1975). The Department's policy paper states that "Where recharge operations would constitute a small fraction of water in the underground, near-term proposals may be acceptable" (California) State Department of Health, 1973). In connection with the Los Angeles Wastewater Facilities Plan, the Department finds that the small amount of reclaimed wastewater from the Sepulveda Reclamation Plant that would infiltrate to the groundwater basin after discharge to the unlined Los Angeles River channel would be acceptable if Regional Water Quality Control Board requirements are met (California State Department of Health, 1975). The Department concludes its comments on groundwater recharge with reclaimed water: "Surface spreading presented as a future option in a plan would be acceptable." Thus, the use of treated wastewater from Sepulveda for spreading purposes is not at this time acceptable, but spreading through the Headworks can be presented as a suitable future option in the L.A. Wastewater Plan.

Although the Department of Health also recommends "against injection for groundwater replenishment as a plan element which is to be implemented in the near future (within the next decade), injection of reclaimed water for saline water repulsion and reclamation of saline aquifer is an acceptable use when accompanied by proper controls." The Los Angeles Wastewater Facilities Plan contains no definite recommendations for injection of reclaimed water. Potential uses to prevent deterioration of groundwater quality in the San Fernando Valley and on the Coastal Plan are discussed in Chapter IV of the Facilities Plan (City of Los Angeles, 1975). Such potential uses are being dealt with on a case-by-case basis by the Department of Health.

Viruses as well as organic residues can pose a problem in water that is injected directly into the aquifer. A research program on viruses in reclaimed water is being conducted by the Los Angeles County Sanitation District (City of Los Angeles, 1975). Also, the Environmental Protection Agency in conjunction with the formulation of national drinking water standards (Section IV.C.1b) is embarking on an intensive organic compounds monitoring and research program. Results are expected before the new drinking water regulations go into effect in June 1977 (EPA, December 1975).

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The Department of Health has expressed opposition to the near-term use of treated wastewater through the Headworks Spreading Ground.

The research findings of these and other agencies may lead to future modifications in the California State Department of Health's position on acceptable uses of reclaimed water.

3. REGIONAL AND LOCAL WATER QUALITY CONTROL PLANS AND REGULATIONS

In the Los Angeles area, federal and state recommendations and regulations relating to water quality are reflected in the Water Quality Control Plan Report, Los Angeles River Basin (4B)(RWQCB, Los Angeles Region 1974). Some limitations contained in the Los Angeles River Basin Plan are more restrictive than requirements established at federal and state levels with the intent of protecting existing and potential beneficial uses. Facilities plans are required to be consistent with basin plans; therefore, the Los Angeles City Facilities Plan (City of Los Angeles, 1975) has been developed with the intention of meeting applicable limitations contained in the Los Angeles River Basin Plan. Furthermore, both facilities planning and basin planning are sensitive to local agency needs and regulations.

Because of this hierarchy of relationships, the Los Angeles River Basin Plan contains the set of water quality goals and regulations most specifically applicable to the Los Angeles City Facilities Plan. The Los Angeles City Facilities Plan proposes a major project, which when implemented, will promote the goals and be consistent with the requirements presented in the Basin Plan.

Basin Plans in California are updated annually and must be amended to include new federal and state requirements applicable to the planning area. The Los Angeles City Facilities Plan is responsive to federal and state regulations even though some of these have not yet been included as amendments to the Basin Plan.

a. Basin Planning. The Water Quality Control Plan for the Los Angeles River Basin (Basin 4B) is the regional plan, adopted by the State Water Resources Control Board, which presents the program of actions to preserve and enhance the water quality of the Los Angeles River Basin. The provisions of the Ocean Plan and of the Thermal Plan are included in the Water Quality Control Plan Report, Los Angeles River Basin (RWQCB, L.A. Region, 1974). The Enclosed Bays and Estuaries Plan was not available at the time of planning (1973) for the Los Angeles River Basin Plan. However, applicable portions of the Enclosed Bays and Estuaries Plan will be implemented through the Regional Board as required in the resolution adopting the plan. Other State Board policy described in Section IV.C.2a is incorporated into the Los Angeles River Basin Plan, and the plan was adopted by the State Board in March 1975.

(1) GENERAL GOALS, MANAGEMENT PRINCIPLES, AND POLICIES OF THE REGIONAL WATER QUALITY CONTROL BOARD, LOS ANGELES REGION. The Regional Water Quality Control Board for the Los Angeles Region based its water quality control plan on a set of goals, management principles, and policies designed to ensure preservation of the beneficial uses of water resources in the Los Angeles River Basin.

These policies emphasize source control and pretreatment of certain industrial and municipal effluents and stress specific management principles in the discharges to tidal waters, bays, estuaries, fresh waters, and groundwaters.

(2) WATER QUALITY OBJECTIVES AND EFFLUENT LIMITATIONS DEVELOPED FOR THE LOS ANGELES RIVER BASIN. Water quality control planning is closely tied to existing and potential water uses. The preservation of existing beneficial uses and of the opportunity for future beneficial uses is a major objective in all basin plans. The State Board has compiled a list of beneficial uses for both surface and groundwaters. These categories and definitions are used in all regional plans in California.

The Water Quality Control Plan Report, Los Angeles River Basin (4B) (RWQCB, L.A. Region, 1974) presents the existing (E), potential (P), and periodic (I, dependent on intermittent flow) uses of water resources in the Los Angeles River Basin. The Basin Plan is intended to preserve the uses, and water quality objectives were developed for this purpose.

The regional plan for the Los Angeles River Basin (RWQCB, L.A. Region, 1974) presents water quality objectives for:

- Ocean waters nearshore and offshore
- Harbors, marinas, tidal prisms
- Fresh inland surface waters
- Groundwaters

Water quality objectives refer, in general, to the quality of receiving waters, and effluents to these waters must be regulated to ensure that the objectives are met. In some cases, specific limitations on effluent quality have been set for discharges to certain types of waters. Both the Ocean Plan and the Thermal Plan include specific effluent restrictions in addition to the objectives set for receiving waters.

(3) RECOMMENDATIONS FOR FACILITIES IMPROVEMENTS IN THE LOS ANGELES RIVER BASIN. The Basin Plan enumerates a series of municipal wastewater treatment improvements which were considered to be in accordance with its recommended water quality objectives vital to the protection of beneficial uses of water. Such wastewater facilities improvements which would affect the City of Los Angeles system are summarized in Table IV-2. These recommendations were all considered in the facilities planning process.

In addition to the general recommendations for facilities improvements, effluent limitations for individual treatment systems within the Los Angeles River Basin are presented in the water quality control plan (RWQCB, Los Angeles Region, 1974). These limitations are intended to control point sources of pollution to the extent feasible so that the water quality objectives of the basin may be met.

Although specific recommendations of the Basin Plan should be used in guiding the actions taken by local public entities "the State and Regional Boards will consider any alternative actions proposed by public agencies which are consistent with the policies and objectives of the plan" (RWQCB, Los Angeles Region, 1974, p. I-5-19).

Table IV-2. Wastewater facilities improvements which would affect the City of Los Angeles system.

ITEM	RECOMMENDED ACTIONS[1]
Provision of Sewerage for unsewered areas	1. Crescenta Valley Co. Water District to connect to Hyperion System via City of Glendale. 2. Chatsworth and Kagel Canyon areas to sewer into Hyperion System. Also Det. Camp. No. 15. 3. When problems later become sufficiently serious, connect to Hyperion or JDS.
Modification of current sewerage arrangements	1. Flow from Bell Canyon and Mulwood areas (San Fernando Hydrologic Subunit) to be sewered by gravity to Hyperion System rather than pumped westerly to Malibu Hydrologic Subunit. 2. Expand Terminal Island T.P. sewerage to include harbor area industrial dischargers. 3. Divert digested sludges from Hyperion and JWPCP ocean discharges to local beneficial uses where suitable and landfill disposal of surplus.
Development of Hyperion System of City of Los Angeles	1. For Hyperion Treatment Plant, provide a secondary treatment by 1977 for all effluent discharged to Santa Monica Bay via 5-mile effluent outfall. Provide tertiary treatment on a portion of the secondary effluent. New secondary capacity (230 mgd) augments existing (100 mgd) capacity. This suffices to Year 2000 and corresponds to capacity of existing plant site. 2. For Hyperion Treatment Plant, provide additional sludge digestion capacity prior to 1977 so that total digestion capacity will be at least 420 tons/day. Enlarge subsequently for 460 tons/day ultimate capacity. 3. For Hyperion Treatment Plant, provide digested sludge dewatering/disposal facilities for 210 tons/day initially and 230 tons/day ultimately. 4. Correct surface/subsurface infiltration into collection system as appropriate, thereby minimizing need for hydraulic relief during high intensity rainstorms. 5. Provide first module of Sepulveda WRP (40 mgd) as soon as possible. This precludes the need for additional Hyperion capacity. It greatly reduces Hyperion System wet weather potential for raw sewage overflows in Culver City and reduces need for hydraulic relief from San Fernando Valley. It produces reclaimed water for local and remote park uses and for groundwater recharge. 6. Provide water reuse facilities within Griffith Park and City of Glendale for LA-Glendale WRP effluent. Enlarge LAGWRP from 20 mgd to 35 mgd capacity in 1990.

[1] The recommended Plan adheres to the mandatory provisions of State and Federal laws and guidelines relative to effluent discharge requirements. These include requirements for secondary treatment of effluent discharged to ocean waters as well as diversion of ocean discharges of sludge to land areas for disposal. The Recommended Plan recognizes that both beneficial and adverse environmental impacts will result from conformance to such requirements and that it does not appear presently possible to determine which impacts will predominate. It therefore includes the provision that should the weight of present and future scientific evidence strongly support the case for less than full secondary treatment (i.e., advanced primary treatment) for coastal plant effluent discharged to suitable ocean outfall-diffuser systems and/or the case for deep ocean disposal of digested sludge as a suitable alternative to land disposal, then future affected facilities should be adopted to permit such future alternatives. The Recommended Plan ackowledges the potential importance of financial aspects and energy requirements in the overall socioeconomic and environmental appraisal.

D. air quality controls and planning

D. AIR QUALITY CONTROLS AND PLANNING

1. FEDERAL AIR QUALITY LEGISLATION

The major federal laws relating to air quality are the Clean Air Act of 1967 (PL 90-148) and the Clean Air Act amendments of 1970 (PL 91-604). The 1967 Act was the result of federal recognition that a national effort would be required "to protect and enhance the quality of the Nation's air resources so as to promote the public health and welfare and the productive capacity of its population." The intent of the law is to provide federal financial and technical assistance to state and local governments which have primary authority for air pollution control planning and implementation. The 1970 amendments to the Clean Air Act set specific goals for improving the nation's air quality. The establishment and enforcement of "primary" and "secondary" standards were authorized and the goal was set of achieving primary standards by mid-1975 with the possibility of a two year extension. Primary standards are those necessary to protect health with an adequate margin of safety, and secondary standards are those "requisite to protect the public welfare from any known or anticipated adverse effects associated with the presence of (an) air pollutant in the ambient air" (PL 91-604 §109). Protecting the public welfare has been interpreted to include property and aesthetics (Council on Environmental Quality, December 1975).

The EPA is the federal agency responsible for administering the federal air quality legislation. Important portions of the law require the EPA to perform the following tasks:

Section 108: Issue and periodically update air quality criteria and information on air pollution control techniques;

Section 109: Establish National Ambient Air Quality Standards (NAAQS) for primary and secondary air quality;

Section 111: Set standards of performance (emission standards) for new stationary sources of air pollutants;

Section 112: Set emission standards for hazardous air pollutants; and

Section 202: Set emission and fuel standards for motor vehicles.

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Other portions of the federal clean air legislation require individual states to take primary responsibility for actions. The major such sections are as follows:

> Section 197: Designate air quality control regions, or air basins, within the state;
>
> Section 110: Adopt a state implementation plan (SIP) for implementing, maintaining, and enforcing NAAQS under Section 109.

Where a state or local authority fails to carry out the responsibilities designated to it by the federal law, the EPA is required to implement the law. Furthermore, citizens may bring suit against the EPA if the Administrator fails to perform the duties assigned to the EPA (Section 304).

a. Planning Programs of PL 91-604. The SIPs required by federal clean air legislation are intended to assure implementation of NAAQS. To receive EPA approval SIPs must:

1. Assure attainment of primary standards as expeditiously as possible but no later than 3 years after plan approval, and specify a reasonable time table for attaining secondary standards
2. Provide emission limitations and compliance schedules which *include land use and transportation controls or other measures necessary* to attain NAAQS [emphasis added]
3. Provide for monitoring
4. Include review and regulatory authority over new sources
5. Provide for intergovernmental cooperation to prevent interference of plan implementation between different regions
6. Provide for adequate personnel, funding, authority, equipment, reporting, etc., for implementation
7. Require inspection and testing of motor vehicles to assure compliance with applicable emission standards
8. Provide for revisions to accommodate new NAAQS or improved methods, or to respond to EPA findings in inadequacy.

In addition to the original requirement for SIPs, EPA has required states to identify areas which have the potential for exceeding any NAAQS in the period 1975-1985 (40 CFR 51.12). These are designated Air Quality Maintenance Areas (AQMAs) and special plans must be developed to deal with the complex and severe problems of AQMAs.

b. Federal Ambient Air Quality Standards. Criteria have been established for particulates, sulfur oxides, carbon monoxide, photochemical oxidants, hydrocarbons (National Air Pollution Control Administration, January 1969a, b; March 1970a, b, c), and nitrogen oxides (U.S. Environmental Protection Agency, January 1971).

2. STATE AIR QUALITY PLANNING AND REGULATIONS

California's air pollution control laws are administered by the California Air Resources Board (ARB). The California laws usually are at least as strict as the federal requirements and some state legislation, including the provision for air pollution control districts, predates major federal legislation. The ARB is responsible for carrying out the mandates of federal legislation as discussed in Section IV.D.1.

a. State Air Quality Planning. Air Pollution Control Districts (APCDs) originally were set up in the state law by counties which were responsible for controlling stationary source emissions. In response to federal requirements to have a single state air pollution control agency and to establish air basins, the ARB was set up and the state was subdivided by topographic relief, into 11 air basins. There was also a provision for voluntary consolidation of county APCDs which fall within a single air basin. Because air basins do not necessarily follow county lines, even reorganized APCDs are not conterminous with air basins. The City of Los Angeles is within the South Coast Air Basin, and the South Coast APCD (SC-APCD) is the regional authority responsible for administering state and federal law in most of the basin (see Section IV.B.3b).

Under federal mandate and state law, the State ARB has primary responsibility for control of emissions from motor vehicles and for preparing the SIP. "The State of California Implementation Plan for Achieving and Maintaining the National Ambient Air Quality Standards" was submitted to EPA in February 1972 (California Air Resources Board, February 1972). The plan contained the state's proposal for controlling emissions from mobile sources plus stationary source controls for each of the state's 11 air basins. The plan has since been revised five times, with the last revision including the designations of AQMAs. Two of the revisions of the 1972 plan mention transportation and land use controls in air basins with serious air pollution problems, but no specific plans were outlined.

Controls, as required by federal legislation, on motor vehicle emissions and on new stationary sources have been implemented in California. However, these measures have not proved adequate to achieve primary NAAQS in several major metropolitan areas even though California's restrictions on motor vehicle emissions are more strict than federal requirements.

In 1974, the South Coast Air Basin was identified as an AQMA (California ARB, June 1974) on the basis of excessive levels of the pollutants carbon monoxide, sulfur dioxide, nitrogen dioxide, oxidants and particulate matter (five of the six pollutants used in setting primary

NAAQS). The situation in the South Coast Air Basin indicates that controls beyond those on individual sources such as motor vehicles and new stationary sources are necessary. The two remaining general planning strategies for controlling air pollution are: (a) to restrict the use of sources through transportation plans that reduce vehicle miles traveled, and (b) to control the distribution of pollutants through land use planning that regulates densities and types of development. Recent air quality planning has shifted emphasis to these types of transportation and land use strategies. For instance, land use is potentially strongly affected by recent controls (40 CFR §51.18) over indirect sources of pollutants such as are encouraged by large shopping centers, amusement parks or other facilities attracting vehicular activity.

The California SIP was disapproved by the EPA on several grounds, including its inadequacy to recommend and implement transportation and land use control strategies which would lead to attainment of NAAQS. The ARB and the APCDs have hesitated to use their authority in the land use and transportation areas. The EPA, accepting its responsibility to implement the law following inaction by the state, promulgated its own "Transportation Control Plan for Southern California" (EPA, 1973), but the elements of the plan for reducing vehicular miles traveled are so severe as to be unenforceable.

b. State Air Quality Standards and Constraints. Where California State standards for air quality differ from NAAQS the stricter ones are those to be enforced. If ambient air quality is worse than primary NAAQS, the APCDs, the ARB, and the EPA have the authority to limit new sources of pollution even if it cannot be proved that the source would, by itself, cause violations. Growth inducing projects as well as new stationary sources are potentially subject to this regulatory control. Because the City of Los Angeles Facilities Plan pertains to an area where there are frequent violations of ambient air quality standards, any growth inducing portions of the plan are subject to regulatory control through the plan approval and funding procedures at state and federal levels. EPA basically permits a local agency to determine the growth to which it intends to plan. However, EPA requires as a condition to its participation in grant funding that the adverse environmental impacts associated or accommodated by that growth be mitigated.

3. REGIONAL AND LOCAL AIR QUALITY PLANNING AND CONSTRAINTS

Air quality planning for the South Coast Air Basin has been attempted in the California SIP and, following rejection of major portions of the SIP, by the EPA (see Section IV.D.2a). Basically, the SIP is ineffective and the EPA's modifications of it are unrealistic. Some of the reactions to state and federal implementation plans have included planning attempts by other regional agencies such as SCAG. SCAG (1974) developed a "Short Range Transportation Plan" in cooperation with the California Department of Transportation (Caltrans). This plan emphasizes preferential treatment of multioccupant vehicles and other measures to increase car pooling and decrease vehicular miles traveled. Other regional and local transportation and land use plans include air quality considerations but none of these plans represents a comprehensive approach to air quality improvement.

A regional effort to provide comprehensive on quality management planning has only been recently initiated for the South Coast Air Basin as a result of the passage in July 1976 of Assembly Bill No. 250 (see Section IV.B.3b). In the development of an Air Quality Maintenance Plan (AQMP) under the authority and direction of ARB, the coordination of federal, state, regional, and local agencies during the planning process is intended to improve the opportunity for developing an acceptable, effective and implementable plan. The South Coast Air Quality Management District that will be directly responsible for the plan commenced operation February, 1977.

Subregional plans will be prepared as part of the final AQMP. Guidelines for these subregional plans may directly affect the City of Los Angeles planning program, for such a plan would affect the service area needs of the City's wastewater treatment facilities. When the AQMP is completed its policies on growth may possibly act as constraints to the implementation of any expansion plans for the City's wastewater treatment facilities.

E. land use and transportation controls and planning

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E. LAND USE AND TRANSPORTATION CONTROLS AND PLANNING

1. FEDERAL PLANNING AND REGULATIONS

The federal government has authority over land use and transportation planning through portions of several important acts, but there is no single piece of federal legislation coordinating or consolidating the various legislative mandates. Federal legislation considered in this section includes the Clean Air Act and Amendments, the Water Pollution Control Act Amendments, the Coastal Zone Management Act, Housing and Community Development Act, and Department of Transportation regulations (several acts).

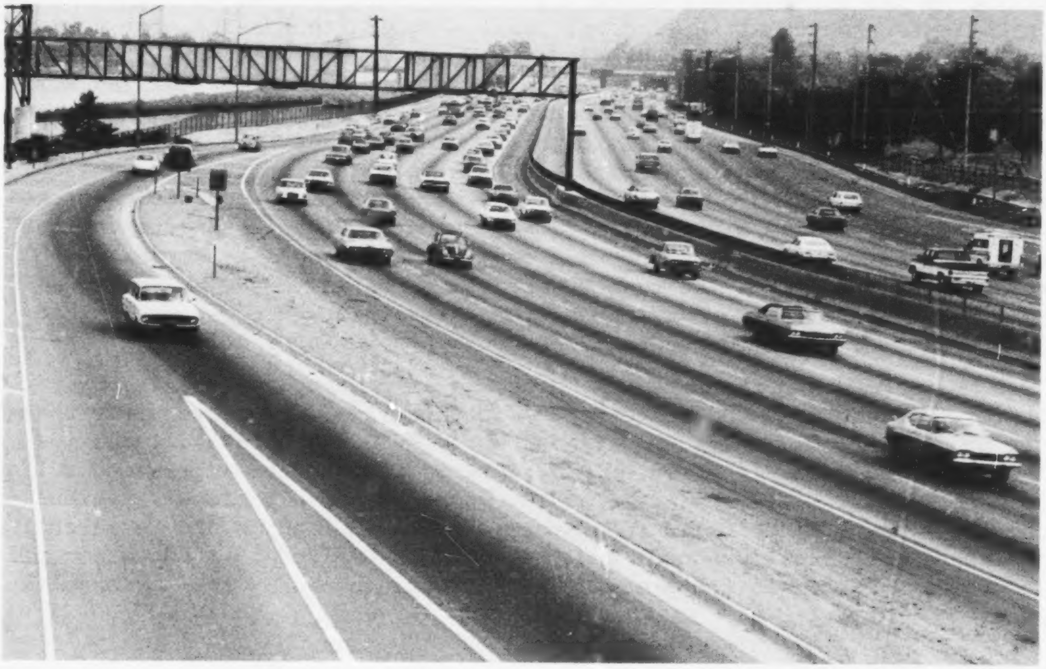
Most of the federal legislation dealing with planning places responsibility at the state or sub-state level, with only general guidelines or objectives mandated at the federal level. Federal guidelines for certain types of planning (such as 208 planning) require coordination with planning agencies carrying out other federal planning programs (such as AQMA planning), but the mechanisms for achieving this coordination usually are not described. Interagency review of completed plans is required by two important federal laws. The first is NEPA (see Section IV.B.1a) which requires an EIS on major federal actions. The process requires that the Draft EIS be broadly distributed to governmental agencies and to the public for a review and comment period of 45 to 60 days, all comments received by the end of the review period must be addressed in the Final EIS. Comments pointing out inconsistencies with other plans could lead to revisions of the proposed actions, but this is not required.

The second important review procedure is required by the federal Office of Management and Budget (OMB) circular A-95. This requires that all projects receiving federal funds be reviewed by a state or areawide A-95 clearinghouse. The review procedure is designed to improve coordination of federal programs and to achieve consistency with local, regional, and state plans. The California State Office of Planning and Research is the state A-95 clearinghouse, and the Southern California Association of Governments (SCAG) is the areawide A-95 clearinghouse in the Los Angeles area.

a. Clean Air Act and Amendments. The Clean Air Act Amendments of 1970 (PL 91-604) require that State Implementation Plans (SIPs) include "such of . . . (air quality standards) . . . including, but not limited to, land-use and transportation controls" (see Section IV.D.1). If the states fail to achieve the federal standards, the EPA is responsible for doing so and the EPA's implementation plan would include land use and transportation controls as necessary.

Other portions of the Clean Air legislation also provide for control over land use and transportation planning. Enforcement of the emission standards for new stationary sources (including expansion or major rehabilitation of existing sources) and for hazardous air pollutants can strongly affect land use especially in an area where air quality is already poor.

b. Water Pollution Control Act Amendments. The federal Water Pollution Control Act Amendments of 1972 (PL 92-500) provide for planning programs that are discussed in Section IV.C.1a(1). Because of the emphasis of Section 208 planning on control of nonpoint sources of water pollution, and on nonstructural alternatives to control pollution, land use planning is an important element of any 208 program. Although the purpose of 208 planning is to improve water quality, the planning guidelines (EPA, August 1975) call for close coordination with EPA's air quality programs and with other areawide management programs.



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The Clean Air Act requires land use and transportation plans to ensure attainment and maintenance of air quality standards.

c. Coastal Zone Management Act. The Coastal Zone Management Act of 1972 (PL 92-583) recognized that state and local arrangements for planning of land and water uses in coastal zones were generally inadequate to deal with the conflicting demands on these areas. The Act emphasizes the need for consideration of ecological and aesthetic values as well as economic development, and provides for grants to states to pay for two-thirds of the cost of developing and administering the state's coastal zone management program.

The Secretary of Commerce, through the National Oceanic and Atmospheric Administration, administers the Coastal Zone Management Act, and reviews the states' management programs for consistency with the views of affected federal agencies. It is required that the management program be consistent with applicable state and federal air and water pollution control standards.

d. Housing and Community Development Act. The Housing and Community Development Act of 1974 (PL 93-383) is administered by the Department of Housing and Urban Development (HUD).

Federal funding through HUD of planning activities provides local authorities with money for comprehensive planning including a land use element by August 1977, but no special requirements are imposed which necessarily affect wastewater facilities planning. Elements of the comprehensive plan which might result in changes in population densities or which would establish new sewer hookups would affect the service areas needs of the wastewater treatment facilities.

2. STATE PLANNING AND REGULATIONS

In California the Office of Planning and Research (OPR) is responsible for comprehensive land use policy planning (see Section IV.B.2e). However, there is no state land use plan, and in the absence of a statewide, comprehensive approach to land use planning, the state agencies whose single-purpose actions necessarily affect land use have strongly influenced growth and development patterns within the state.

The land use planning roles of the ARB and SWRCB have already been discussed in the sections on air quality planning (see Section IV.D.2a) and water quality planning (see Sections IV.C.2 and IV.C.3). Transportation planning is carried out by the California Department of Transportation (Caltrans); Comprehensive Planning Assistance programs are handled through OPR; public lands, including offshore areas, are administered by the State Lands Commission, while state water projects are planned by the Department of Water Resources (DWR). The California Coastal Commission is responsible for multipurpose planning the state's coastal zone (Section IV.B.2d).

a. Office of Planning and Research. OPR's activities which affect planning include its functions as the state A-95 clearinghouse (see Section

IV.E.1), its responsibility for CEQA guidelines (see Section IV.B.2e), and its administration of HUD 701 and Comprehensive Planning Assistance funds (see Section IV.E.1d). Although OPR administers the planning assistance programs of HUD, the plans are developed at the local or regional level.

b. California Department of Transportation. Caltrans was formed by 1972 legislation known as AB 69 (California Government Code, Section 65080 et seq.). Federal requirements for state and sub-state roles in highway and mass transit planning are satisfied by the AB 69 legislation. Caltrans was required to produce a statewide comprehensive transportation plan by January 1, 1976. Forty-one Regional Transportation Planning Agencies were also established by AB 69, and these were required to produce Regional Transportation Plans (RTPs) which were incorporated into the State Plan. Updates of the State Plan and RTPs are required annually for two years and then biannually. RTPs are based on subregional transportation plans generated by the component counties and/or cities. The RTP including the Los Angeles area is discussed in Section IV.E.3b.

c. State Lands Commission. The State Lands Commission, created in 1867, is an independent agency with the responsibility for administering ungranted and unpatented public land. Its authority includes the issuance of permits for private use such as offshore oil drilling in areas with state jurisdiction. Because offshore activities may impact onshore development, future decisions of the State Lands Commission could affect the needs of the Facilities Plan service area. There are no long-term plans available to direct Commission decisions.

d. Department of Water Resources. The Department of Water Resources (DWR) is within the state's Resources Agency. Its director plus the nine-member California Water Commission constitute the rule-making authority of DRW.

DWR is responsible for conserving, developing, and transporting water resources within the state. It investigates water needs and availability and oversees the State Water Project which includes the State Aqueduct. Because an important water supply is frequently an essential element for urbanization and for agriculture, the allocation of the state's water resources has had a strong influence on land use. In the absence of a comprehensive state land use plan, DWR has prepared many of its own projections. Implementation of DWR projects affects the potential for growth, facilitating it in areas where growth was projected, and restricting it where water supply is inadequate to meet expanding needs.

Facilities planning is affected by water supply planning even more directly than through water supply influences on land use. The quality of the water supply affects treatment requirements, and the availability of water affects the volume utilized by the existing population. Limited water supplies requiring rationing or restrictive pricing will reduce the need for treatment capacity to the extent that the water conserved is that which otherwise would have entered the sanitary sewer system.

The City of Los Angeles obtains 80 percent of its water supply from the Owens Valley through two city-owned aqueducts. Although the City plans to increase its use of Owens Valley water, there has been pressure to pursue other alternatives. The City purchases about 6 percent of its water from the Metropolitan Water District which supplies a total of about 10.5 million people from primarily the State Water Project and the Colorado River. Additional state water would be available to the City of Los Angeles through allocations to the Metropolitan Water District, but the cost of this water is expected to be high and would not be controlled by the City (City of Los Angeles, Department of Water and Power, May 1976). Because of its entitlement of State Water Project water, the potential water supplies to the City are more than adequate for the foreseeable future, but the cost of obtaining the water could be prohibitive. This cost constraint has acted to encourage planning for the use of reclaimed water, although the possibilities currently are limited (see Section IV.C.2b).

3. REGIONAL AND LOCAL PLANNING AND REGULATIONS

The regional and local plans affecting land use and transportation in the City of Los Angeles' wastewater treatment facilities service area include primarily the City of Los Angeles General Plan, the Los Angeles County General Plan, the SCAG Development Guide, and the regional planning efforts of state agencies such as ARB, SWRCB, Caltrans, and the Coastal Commission.

These plans might potentially act as constraints to implementation of the facilities plan where funding is dependent upon conformance with particular plans or where growth pattern developing during the facilities planning period affect the need to implement phases of the project that are scheduled for 10 years or more in the future.

There are several specific constraints on facilities planning and implementation that relate directly to the use of population projections which are, in turn, related to land use and transportation planning. First, the Facilities Plan is required to be in conformance with the Los Angeles River Basin Plan.

Second, because the City of Los Angeles is planning the proposed facilities to serve primarily its own population, and the City is obligated to meet the needs of its population, its planning for facilities might be expected to be consistent with City land use plans and population projections.

a. Regional Water Resources Control Board Plans and State Water Resources Control Board Requirements. The Water Quality Control Plan Report, Los Angeles River Basin (4B)(RWQCB, March 1975), is the Basin Plan (303 [e] plan) adopted by SWRCB with which the Facilities Plan must be consistent (see Section IV.C.3a). The water quality control plans described in the Basin Plan are based on State Department of Finance (DOF) population projections that were issued in 1971. The 1974 revised DOF projections were not available soon enough to incorporate into the planning process (SWRCB, March 1975). However, the Basin Plan states that design capacity for individual wastewater facilities will be determined using the most current DOF projections.

The Clean Water Grants Program (California Administrative Code §§ 2100 et seq.) is administered by SWRCB to implement the Clean Water Bond Law of 1970 (Water Code, Division 7, Chapter 13). The funding process is in cooperation with the EPA and provides financial assistance for treatment works. Federal funds are limited to 75 percent, and state funds to 12.5 percent, of grant eligible portions of wastewater treatment project costs (see Sections IV.C.1a[1] and IV.C.3c). The municipality, therefore, is responsible for as little as 12.5 percent of total project costs.

Limitations on funding of treatment plants are set according to capacities (§§ 2132 through 2138). Treatment works are to be designed "to accommodate normal anticipated growth and reasonable reserve capacity." However, eligible project costs for projects in critical air areas (or AQMAs) are limited to capacities based on the most current DOF E-O population projections. If a municipality proposes reserve capacity great enough that the growth inducing impacts would have adverse effects outweighing benefits, the SWRCB may deny the grant altogether.

The most current DOF E-0 projection is that of 1974. The use of this projection would be consistent with the Basin Plan statement that design capacity for individual facilities should be determined using the most current DOF projections (see above). The City of Los Angeles believes that the 1974 DOF E-0 projections "does not represent a prediction of the future, but the minimum plausible population trend and one which some agencies would like to see occur" (City of Los Angeles, June 1976). According to this view, capacity designed for the 1974 DOF E-0 population projection would not "accommodate normal anticipated growth" as required by the Clean Water Grants Program.

The projections considered by the City to most accurately predict population are those adopted by the SCAG Executive Committee on December 11, 1975. These SCAG-76 projections are based on a 1974 DOF D-100 series and projection with allocations made to the 55 regional statistical areas of the six-county SCAG area. The Facilities Plan compares the 1974 DOF E-O and SCAG-76 projections and the selected plan is based on SCAG-76 projections. If the treatment capacity is in excess of the 1974 DOF E-O projection proves to be ineligible for state and federal funds, 100 percent rather than 12.5 percent of that portion of the project cost would have to be borne by the City. This could prove to be a serious constraint to project implementation.

In addition to the funding limitations based on population, the Clean Water Grants Program limits the fundable per capita flow estimated for future development. The restriction is to 100 gallons per capita per day or present actual per capita flow, whichever is *less*. Because the Facilities Plan uses in its projections, current per capita flows which are above 100 gallons per day, the difference in project costs may not be fundable.

b. SCAG Regional Plans and Projections. The SCAG activities include preparation of projections of population and growth. SCAG adopted regional planning goals and policies in 1973. These serve as the core of the Regional Development Guide (SCAG, 1974) which is supplemented by the growth forecasts. SCAG-76 Growth Policy Forecast (SCAG, December 1975) is the most recently adopted.

SCAG requires that population and employment rates used in estimating the Facilities Plan flows be consistent with the goals of the region, including the goal to retain the quality of life in the San Fernando Valley.

SCAG uses its Regional Development Guide to generate action programs for HUD 701 projects, to generate the Regional Transportation Plan, and to review plans according to its A-95 clearinghouse responsibilities. SCAG can also be expected to use the Regional Development Guide and its own growth forecasts in preparing the 208 plan for which SCAG is the responsible regional planning agency, and for providing input to the Air Quality Maintenance Plan (AQMP).

As the Regional Transportation Planning Agency for Caltrans covering Los Angeles, Ventura, Orange, Imperial, San Bernardino, and Riverside Counties, SCAG has prepared the 1975 RTP (SCAG, 1975) and the 1976 RTP update (SCAG, 1976). These documents recognize the strong relationship between land use planning and transportation planning.

The RTB emphasizes measures to reduce vehicle miles traveled in the Los Angeles basin, and is directed toward eventual mass transit services. If the goals of the RTP are met, the plan should serve to encourage fulfillment of SCAG's population and land use projections. This would facilitate implementation of the Facilities Plan because of the use of similar projections.

The various planning projects with which SCAG is involved will be used by SCAG to meet the U.S. Department of Housing and Urban Development (HUD) requirement, effective August 1977, for a land use element in a region's comprehensive plan. The current planning documents produced by SCAG include "Revisions to Areawide Plan and Program for Water Quality Management, December 1974."

The 1977 land use plan, and the other regional plans prepared or coordinated by SCAG, will all be developed from a reasonably consistent data base. The A-95 review function of SCAG also encourages the use of SCAG forecasts in projects not controlled by SCAG. As multiple plans using the SCAG projections are implemented, the likelihood of the projections proving accurate will increase. This should increase the probability that the proposed Facilities Plan, also based on SCAG projections, will be appropriate to the future needs of the service area and will be fully implemented.

c. City of Los Angeles General Plan. According to state law, a General Plan is required for counties, general law cities, and charter cities. The elements which must be included in the plan are: land use, housing, conservation, circulation, open space, seismic safety, noise, and scenic highways.

In April of 1974, the Los Angeles City Council adopted "Concept Los Angeles" for the General Plan and the Citywide Plan. The long-range "Concept" portion of the General Plan serves as a generalized conceptual framework for the entire General Plan and includes broad policies for such matters as housing, land use, and transportation. The Citywide Plan is directed to the next 20 years, and as such, represents the initial stage in the achievement of the City envisioned in the Concept.

In addition to the Concept and Citywide Plan, the Planning Department is responsible for preparing 20-year policy (including generalized land use) plans for 35 planning areas composed of 70 communities within the City. These plans must be in conformance with the Concept and Citywide Plans. They are accompanied by implementation reports which contain program priorities and recommended actions designed to carry out the plan over the next five years.

It is the City's policy that "coordination of services and integration of facilities of different public agencies be encouraged" and that "municipal services and facilities be provided for all segments of the population on the basis of need and the City's ability to finance" (City of Los Angeles, 1974).

d. Los Angeles County General Plan. The General Plan for Los Angeles County is currently being revised as a result of a 1975 decision in Superior Court Case No. C-63218, *Coalistion for Los Angeles County Planning in the Public Interest, et al. v. the Board of Supervisors, et al.* The suit grew out of a controversy resulting from the amendments to the Plan, adopted by the Board of Supervisors on June 28, 1973, which modified an earlier preliminary General Plan adopted October 1, 1970, entitled the *Environmental Development Guide* (Los Angeles County Regional Planning Commission, undated). The court agreed with the plaintiffs that the amount of land designated for urban expansion had an ultimate carrying capacity substantially larger than projected population, hence, the land use plans were compatible with, but not limiting on population growth in Los Angeles County. The Court noted other inconsistencies and found the Environmental Impact Report related to the Plan Amendments to be inadequate (Los Angeles Regional Planning Commission, undated).

An injunction resulting from the court decision now limits the authority of the Los Angeles County Regional Planning Commission and the Los Angeles County Department of Planning to process and act on plan amendments, land divisions, and zoning cases. The injunction also limits the County Engineer's ability to process building permits. In the interim period until a reconstructured general plan can be adopted, both the Zoning and Subdivision Ordinances must be administered under restraint of the court's injunction. In addition to land use measures and policies, revisions will be made to the housing, environmental quality, transportation, public services and facilities, and recreation and open space elements. The revision process will result in a recommended plan in mid-1977; the plan will affect the development of unincorporated areas, but is only advisory for cities.

e. California Coastal Plan. The coastal plan was submitted to the legislature in 1975. SB 1277 was then written to adopt major features of the plan and to create a permanent statewide California Coastal Commission effective January 1, 1977. The new law, approved in September 1976, is mostly set forth in the Public Resources Code, Section 30000 et seq., but it also added to the California Water Code a Section 13142.5 which outlines the state's policy on water quality as it relates to the coastal marine environment (see Section IV.B.2d). The Coastal Commission may review certain aspects of the development of a wastewater facility (Pub. Res. Code, 30412), and, to promote greater efficiency in planning long range land use development for public works, it permits a procedural alternative to project-by-project review (Pub. Res. Code 30605). SB 1277 and its subsequent embodiment in the codes are summarized in Section IV.B.2d.

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Cessation of overflow into Ballona Creek, included as part of the Facilities Plan, is consistent with the California Coastal Plan's goal of restricting the expansion of substandard sewer systems.

F. noise standards affecting construction and operation

F. NOISE STANDARDS AFFECTING CONSTRUCTION AND OPERATION

1. LEGISLATION

Federal, state, and local governments have established noise-limiting ordinances to protect citizens from potential physiological (such as hearing damage) and psychological effects of moderate and excessive noise levels.

The California Noise Standards were established after weighing economic and technological feasibility, and represent the most thoroughly considered public policy to date. Table IV-3 shows current standards that have been used as the basis of evaluation in this study.

The Noise Control Act of 1972 provides for the establishment of federal noise emission standards for new products and requires that the noise emission and reduction characteristics of such products be printed on the new product labels. The Act also authorizes the EPA to issue noise emission standards for motor carriers engaged in interstate commerce, to recommend regulations to the FAA which the EPA believes are necessary to regulate aircraft noise, and to coordinate federal research activity in noise control. The Act prohibits state and local governments from setting noise emission levels different from those established by the EPA for noise sources covered under the Noise Control Act. The EPA is authorized to assist local and state governments in the development and enforcement of noise standards to regulate the use, operation, or movement of products and other noise sources whose control is not preempted by federal regulations.

Table IV-4 compares various federal noise standards including the Occupational Safety and Health Act (OSHA) passed in 1970, Draft No. 2 noise recommendations by the EPA, HUD standards, and Federal Highway Administration guidelines.

2. THE EFFECTS OF NOISE

The hearing mechanism of humans allows reception of acoustical pressure, amplification of faint signals, attenuation of loud sounds, and conversion to impulses that are transmitted to the brain for interpretation. Studies have revealed the tremendous range of acoustical pressures that can be perceived as sound by man. Pressure fluctuations which are as small as 29×10^{-10} pounds per square inch (0 dB) can be detected as faint sound by most young healthy persons; and pressures

Table IV-3. State of California motor vehicle noise limits.

DESCRIPTION	EFFECTIVE DATE	Noise Standards (dBA values at 50 ft. unless noted otherwise) 35 MPH OR LESS	 OVER 35 MPH
Operations of Vehicles at Posted Speeds			
1. Motorcycle		85	86
2. Vehicle with a Gross Vehicle Weight of 6,000 Pounds or More (or combination)	Before 1/1/73	88	90
	After 1/1/73	86	90
3. Any Other Motor Vehicle and Any Combination of Motor Vehicles Towed by Such Vehicle		76	82
Sale of New Vehicles			
1. Motorcycles Manufactured	Before 1970		92
2. Motorcycles, Other than Motor-driven Cycles, Manufactured	1970-72		88
	1973-74		86
	1975-77		80
	1978-87		75
	After 1987		70
3. Vehicle with a Gross Vehicle Weight of 6,000 Pounds or More	1968-72		88
	1973-74		86
	1975-77		83
	1978-87		80
	After 1987		70
4. Any Other Motor Vehicle	1968-72		86
	1973-74		84
	1975-77		80
	1978-87		75
	After 1987		70
Noise Levels Limits for the Operation of Off-Highway Motor Vehicles	On or After 1/1/72 Before 1/1/73		92
	After 1/1/73 Before 1/1/75		88

Table IV-4. General comparison of Federal Noise Standards.[1]

A-WEIGHTED SOUND PRESSURE LEVEL dBA	MAXIMUM RECOMMENDED DURATION PER 24-HOUR PERIOD				
	OSHA LIMITS[1]	DRAFT EPA LIMITS[2]		HUD LIMITS[2] (exterior)	FEDERAL HIGHWAY ADMINISTRATION
		ANNOYANCE	HEALTH		
45	24 Hours	24 Hours	24 Hours	30 Minutes/24 Hours[3]	24 Hours
50		24 Hours		24 Hours	
55		8 Hours		24 Hours	
60		160 Minutes		24 Hours	
65		53 Minutes		8 Hours[4]	
70		18 Minutes		8 Hours[4]	24 Hours
75		6 Minutes	24 Hours	8 Hours	21 Hours
80		2 Minutes	8 Hours	8 Hours	3 Hours
85	24 Hours	40 Seconds	160 Minutes	1 Hour	
90	8 Hours	13 Seconds	53 Minutes		
95	4 Hours	4 Seconds	18 Minutes		
100	2 Hours	1 Second	6 Minutes		
105	1 Hour	1 Second	4 Minutes		
110	30 Minutes	0.5 Second	2 Minutes		
115	15 Minutes	0.2 Second	40 Seconds	1 Hour	3 Hours

[1] Industrial. (OSHA is the Occupational Safety and Health Act)
[2] Residential, outdoor. (EPA is the Evironmental Protection Act)
[3] Indoor.
[4] Periods from 8-29 hours may be permitted if accompanied by an analysis showing mitigation for interior habitation.

Table IV-5. External noise exposure standards of the U.S. Department of Housing and Urban Development for new construction sites.

CATEGORY	TIME PERIODS
Unacceptable	Exceeds 80 dBA for 60 minutes per 24 hours Exceeds 75 dBA for 8 hours per 24 hours
Normally Unacceptable	Exceeds 65 dBA for 8 hours per 24 hours
Normally Acceptable	Does not exceed 65 dBA for more than 8 hours per 24 hours
Acceptable	Does not exceed 45 dBA for more than 30 minutes per 24 hours

as high as 0.0029 pounds per square inch (120 dB) are often perceived by people without serious hearing damage.

However, phenomenal as human hearing may be, there are certain limits beyond which damage will occur to the delicate hearing mechanism. It is an accepted fact that most people will experience permanent hearing damage if exposed to sound pressure levels exceeding 160 decibels, or 0.20 pounds per square inch (psi), for only a few seconds. More recent studies have shown that, although most people can endure moderately high sound pressure levels for varying durations, the hearing ability of people will deteriorate at a rate depending on level and duration of exposure. Table IV-6 shows that sound pressure level for some typical daily events.

Community reaction to various noise levels is shown in Figure IV.F-1. Examination of this figure shows that changes in the order of 1 to 2 dB generally are not detectable by the population in any statistically significant way. The grey band shows the tolerance of people to increased noise levels, with the variation in sensitivity to community noise being about 10 dB wide in normalized units. At a value of 75 (in dB), legal action or strong appeals to local officials to stop noise can be expected by 90 percent of the population.

3. THE EFFECTS OF METEOROLOGICAL CONDITIONS AND ALTITUDE

Sound levels received at the ground receiver are affected in four ways: by temperature, altitude, humidity, and wind. Specifically:

- Sound transmission loss increases with increasing temperature. The higher the frequency, the larger the effect.
- Sound transmission loss increases with increasing altitude above sea level.
- Sound transmission loss increases with decreasing humidity.
- Wind will cause a skewing in the noise radiation pattern of a source in the direction of the wind.

The propagation parameters of sound vary significantly with ambient temperature, humidity, and altitude. The effects are complex and can only be plotted relative to the spectral characteristics of the source.

Table IV-6. Sound levels and loudness of illustrative noises in indoor and outdoor environments. (A-scale weighted sound levels).

	OVERALL LEVEL (Sound pressure level approximately 0.0002 microbar)	COMMUNITY (outdoor)	HOME OR INDUSTRY (indoor)	LOUDNESS (human judgement of different sound levels)
130		Military jet aircraft takeoff with after-burner from aircraft carrier at 50 feet (130)	Oxygen Torch (121)	
120	Uncomfortably Loud	Turbofan aircraft at takeoff power at 200 feet (118)		120 dBA 32 Times as loud
110		Boeing 707, DC-8 at 6,080 ft before landing (106) Jet flyover at 1,000 feet (103)	Riveting Machine (110) Rock-N-Roll Band (108-114)	110 dBA 16 times as loud
100	Very Loud	Bell J-2A Helicopter at 100 feet (100) Boeing 737, DC-9 at 6,080 feet before landing(97) Power Mower (96)	Newspaper Press (97)	100 dBA 8 times as loud
90		Motorcycle at 25 feet (90) Car Wash at 20 feet (89) Prop. Plane flyover at 1,000 feet (88) Diesel Truck, 40 mph at 50 feet (84) Diesel Train, 45 mph at 100 feet (83)	Food Blender (88) Milling Machine (85)	90 dBA 4 times as loud
80	Moderately Loud	High Urban Ambient Sound (80) Passenger Car, 65 mph at 25 feet (77) Freeway at 50 feet from Pavement Edge, 10 A.M. (76 ± 6)	Garbage Disposal (80) Living Room Music (76)	80 dBA 2 times as loud
70			TV-Audio, Vacuum Cleaner (70) Cash Register at 10 ft. (65-70) Electric Typewriter at 10 ft. (64)	70 dBA
60		Air Conditioning Unit at 100 feet (60)	Dishwasher (rinse) at 10 feet (60) Conversation (60)	60 dBA 1/2 as loud
50	Quiet	Large Transformers at 100 feet (50) Bird Calls (44)		50 dBA 1/4 as loud
40		Lower Limit, Urban Ambient Sound (40)		40 dBA 1/8 as loud
	Just Audible	(dBA Scale Interrupted)		
10				

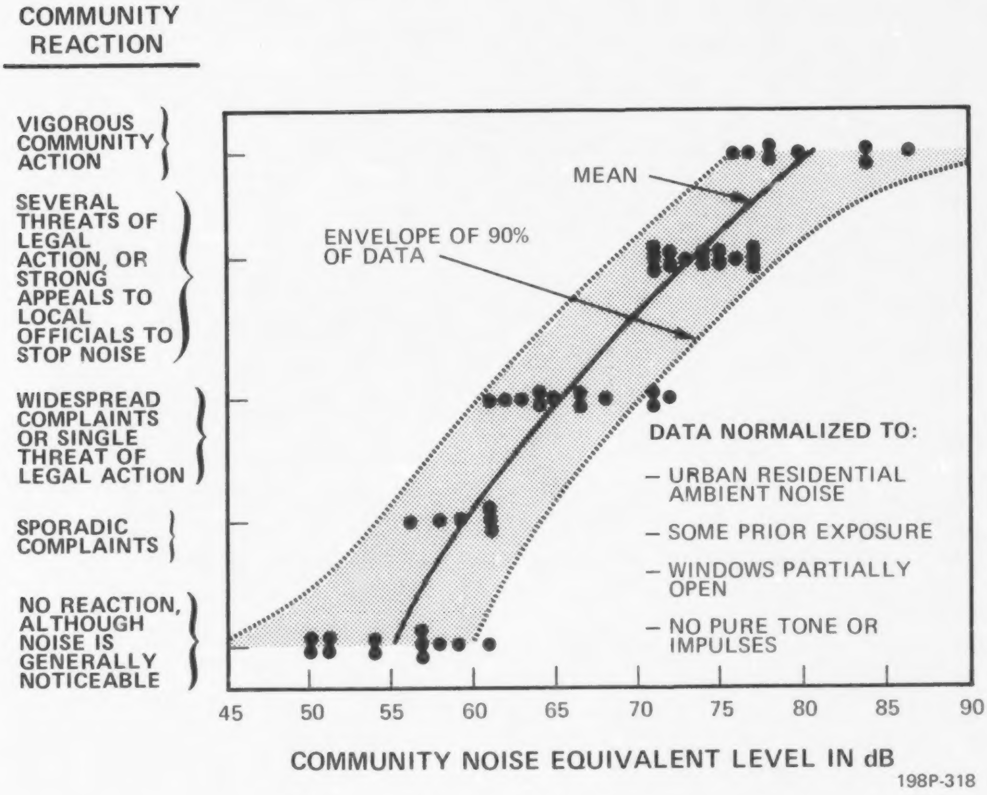
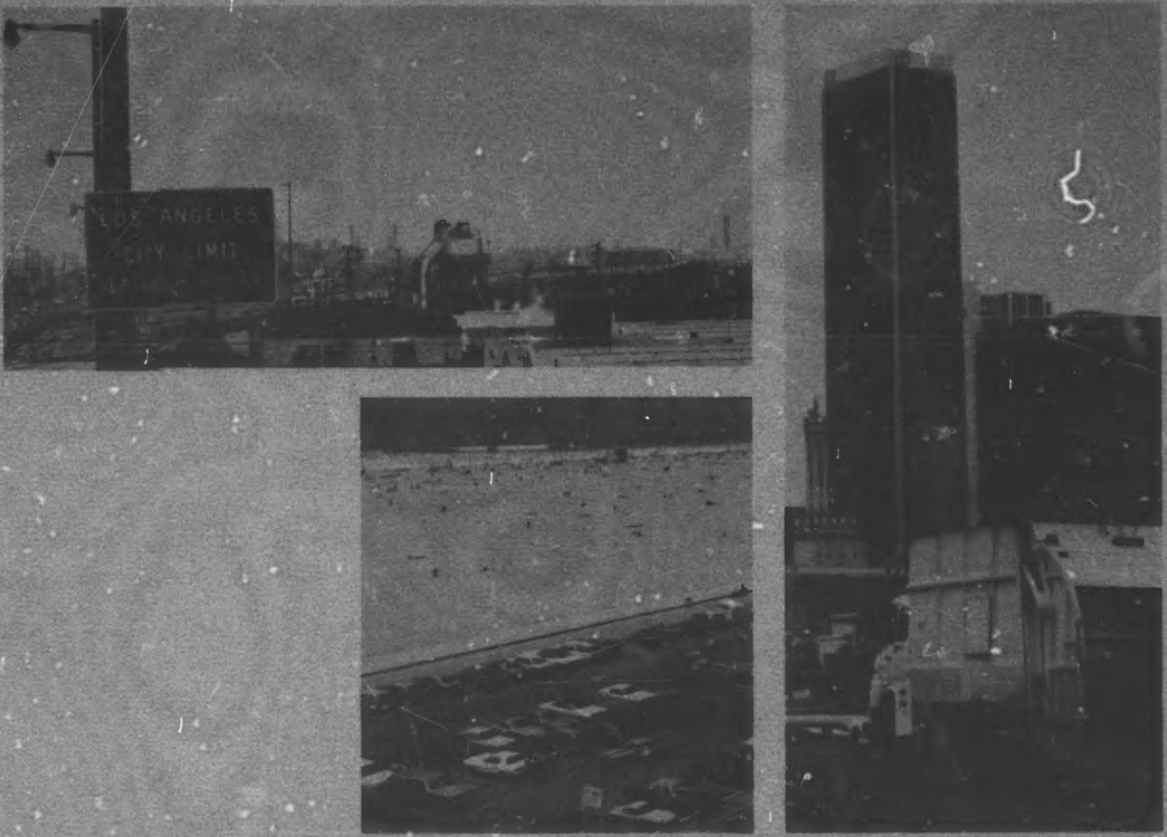


Figure IV-1. Community reaction to intrusive noises of many types as a function of the community noise equivalent level.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Chapter V

development of impact causes

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A. introduction

A. INTRODUCTION

The environmental quality and population patterns in the Los Angeles area are the result of a unique interaction of climate, large areas of flat, buildable land, the transportation system, the nature of local developers' practices, the availability of utilities, economic factors that determined the nature and timing of development, and the aspirations of the people who migrated to Southern California. This brief chapter provides a perspective on impact causes and the spatial distribution of growth in the City of Los Angeles' historical development.

This chapter sets the stage for the dynamic elements operating upon the existing environment which must be taken into consideration by professionals designing plans such as the Facilities Plan. The dynamic nature and causative factors within the City of Los Angeles can significantly affect planned growth and development as well as work to support or deny mitigative measures designed to improve environmental quality.

All population dynamics - and as regards development, economic activity - affects the "community quality" which is an integrated web of both human and natural factors occurring within the Los Angeles area. If the use/environmental capacity is exceeded by the introduction of some new factor, a different pattern of life will be generated involving a new balance of those elements. Growth into an urban media adds several new dimensions, the most important of which are environmental quality and functional use; these factors must be related to previous human-environmental relationships to understand the cause-effect relationship.

The high degree of interrelation among economic resources, land uses, public services, and desired quantity/quality states in urban growth dynamics underscores the fact that tradeoffs must inevitably be made among desired production-consumption levels, resource uses, and a cleaner, healthier, and more pleasant environment. A working definition of "community quality" requires an interactive series of adjustment to reconcile the "environmental capacity" related to quality levels of the natural environment and desired levels of consumption of goods and services by society as changes occur.

Development in Los Angeles has involved a process of change from an agricultural or rural pattern of living to an urban/industrial community. The forces which have acted to alter the former environment and create a new environment are complex, often acting simultaneously and are not easily separated.

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B. cause-effect relationship

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B. CAUSE-EFFECT RELATIONSHIP

The consequences of actions taken by the City of Los Angeles years and decades ago, yet only recently perceived, concerning issues of growth, transportation and utilities, the economy, and community quality have underscored the necessity and value of comprehensive impact analysis. Growth trends have been used historically as measures of performance and have become increasingly useful in recent years. They are, in principle at least, a device for establishing benchmarks - where we were yesterday compared to where we are today, in which directions we are progressing, and what route we should chart to achieve a goal. Success of this approach lies mainly in one's ability to interpret "signals" which growth indicators may give in advance of change - including the rates and/or direction of change.

In the most basic terms, natural resources, the individual as primary mover, and society affect the environment. The hypothesis to be developed here is that the prime mover historically has been the individual seeking economic opportunity coupled with a number of secondary movers including societal response, natural phenomena, availability of natural resources, communications, transportation, public services, and environmental quality. It will be shown that the role of each of these motivating forces changed as the City evolved from pioneer settlement to rural/agricultural to emergent urban/industrial.

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C. growth patterns

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C. GROWTH PATTERNS

Population forecasts are basic to any rational plan for the future of a key service system. The sizing of almost every component of the system is directly related to capacity and constraints which in turn proves to be almost a linear function of population, even when industrial and commercial projections are included. Three general classes of population data are pertinent: past population trends, present population estimates, and future population projections. Two general mechanisms operate to determine the population of an area: 1) birth and death rates, and 2) migration. These matters have been considered in the analysis of the City's population development. Since the founding of Los Angeles in 1781, the City has experienced four population booms.

The first, the "Boom of the Eighties," was triggered by the opening of the second direct transcontinental rail route, the Santa Fe, in the mid-1880s. This stimulated the growth of agriculture by linking the west to the eastern markets. As a result, the population doubled during the 1890s to 50,000 (Lantis, Steiner, and Karinen, 1973).

The second boom between 1902 and 1914 tripled the population again, making Los Angeles a small metropolis. Rapid growth of the City and its environs occurred as agriculture, tourism, and oil were further developed and the motion picture industry was established. Also, the confirmation of San Pedro as a principal seaport in 1899, and the completion of the third transcontinental rail link (now part of the Union Pacific) in 1905 stimulated food processing and other industrial development. Los Angeles eliminated the dependence upon its own river water when the Los Angeles Aqueduct was completed in 1913. Existing surface and groundwater supplies could support a population of no more than 200,000 before the Aqueduct was completed (City of Los Angeles, Department of Public Works, 1975). The additional water supply enabled the City to absorb many outlying districts, including nearly the entire San Fernando Valley, where supplies were inadequate, and by 1920 Los Angeles had a population of 580,000 (Lantis, Steiner, and Karinen, 1973).

Los Angeles experienced its third boom during the 1920s when the absolute population increase within the city limits established an all-time record. By 1930, after a decade of major economic change, it was the Nation's fifth largest city, with a population of 1.2 million (Lantis, Steiner, and Karinen, 1973). Growth was promoted by petroleum and the effects of the automobile. Much oil revenue was reinvested in the Los Angeles area in tool manufacture, land, rubber processing, and automobile assembly plants.

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The fourth boom began during World War II with much industrial expansion, particularly in aircraft, and continued until 1969. The largest accumulation occurred by major inmigration into the City and high birth rates. In the last census period the growth rate tapered to 13 percent.

One consequence of the post-war "baby boom" years was that in 1970 the City was populated with a higher percentage of young people than in 1940. During the 1950s, 60 percent of the added inhabitants were twenty years of age and under. During the 1960s this youthful population began to show evidence of an increase in median age. This is in part caused by longevity. However, since the 1930s peak in senior citizen growth, the additions to the younger age groups have overshadowed increases in the City's elderly population.

In 1940 minority residents accounted for approximately 14 percent of the total population. In 1970, the figure was 41 percent, including 18 percent Black, 19 percent Chicano, and 4 percent Asian-American persons. Close to 85 percent of the 1.6 million non-anglo residents of 1970 were gained within the last two census decades. The 1960s marked the period of largest increase.

The forties marked the last period of somewhat symmetrical City growth. Each of the geographic areas contributed to the 31 percent gain in residents. It was, however, the San Fernando Valley and West Los Angeles that garnered the greatest proportion of added inhabitants. South Los Angeles (constrained by poor accessibility), and Central (the oldest, most developed section of the City), were the smallest contributors. The Central geographic area, however, accommodated the largest portion of the City's 108,000 additional senior citizens and most of its 69 percent increase in minority residents.

Most of the City's growth in the 1950s was the result of large-scale residential development within the San Fernando Valley. The Valley was the major destination of young, white migrants, and thereby the locale of the largest gains in children and adolescents. No other section of the City matched the growth pace of the Valley during this period. The Central area's total population declined 4 percent; its most severe loss occurred among working age adults. West Los Angeles, in community size and population composition, approached maturity to become the only sector of the City wherein the adult population (20-59 years) grew at a faster rate than the under-twenty population. The smallest increase in population for the thirty-year period occurred within South Los Angeles.

The combined factors in the 1960s of the unavailability of low-cost land, community maturity, decreased birth rates and slowed inmigration diminished the Valley's capacity for sustaining its massive expansion of the previous decades. Without these stimuli, city growth, still largely predicated on increases in the San Fernando Valley, tapered to the more conservative rate of 13.5 percent.

In each of the City's geographic areas except Central, more mature age groups became characteristic. The Valley, West and South Los Angeles each gained their most substantial increases within the 20- to 59-year old age ranges. The percentage of youth in the total population dropped. In West Los Angeles this drop represented an absolute loss of 6 percent in its 0- to 19-year olds. In Central a counter trend was effected; the number of working age adults continued to diminish as first evidenced in the fifties, while increases in the number of youth reached a thirty-year peak.

The estimated population of metropolitan Los Angeles in 1970 was 9 million, a figure which was exceeded only by the greater New York area. The City of Los Angeles, which at one time contained almost 60 percent of the metropolitan residents, now has only 30 percent of the people (circa 2.8 million) as outlying localities have rapidly developed. The population growth for the Los Angeles City and Los Angeles County and the five county area are plotted on the bottom of Figure V-1, along with the 1990 projections for the City in the four major areas.

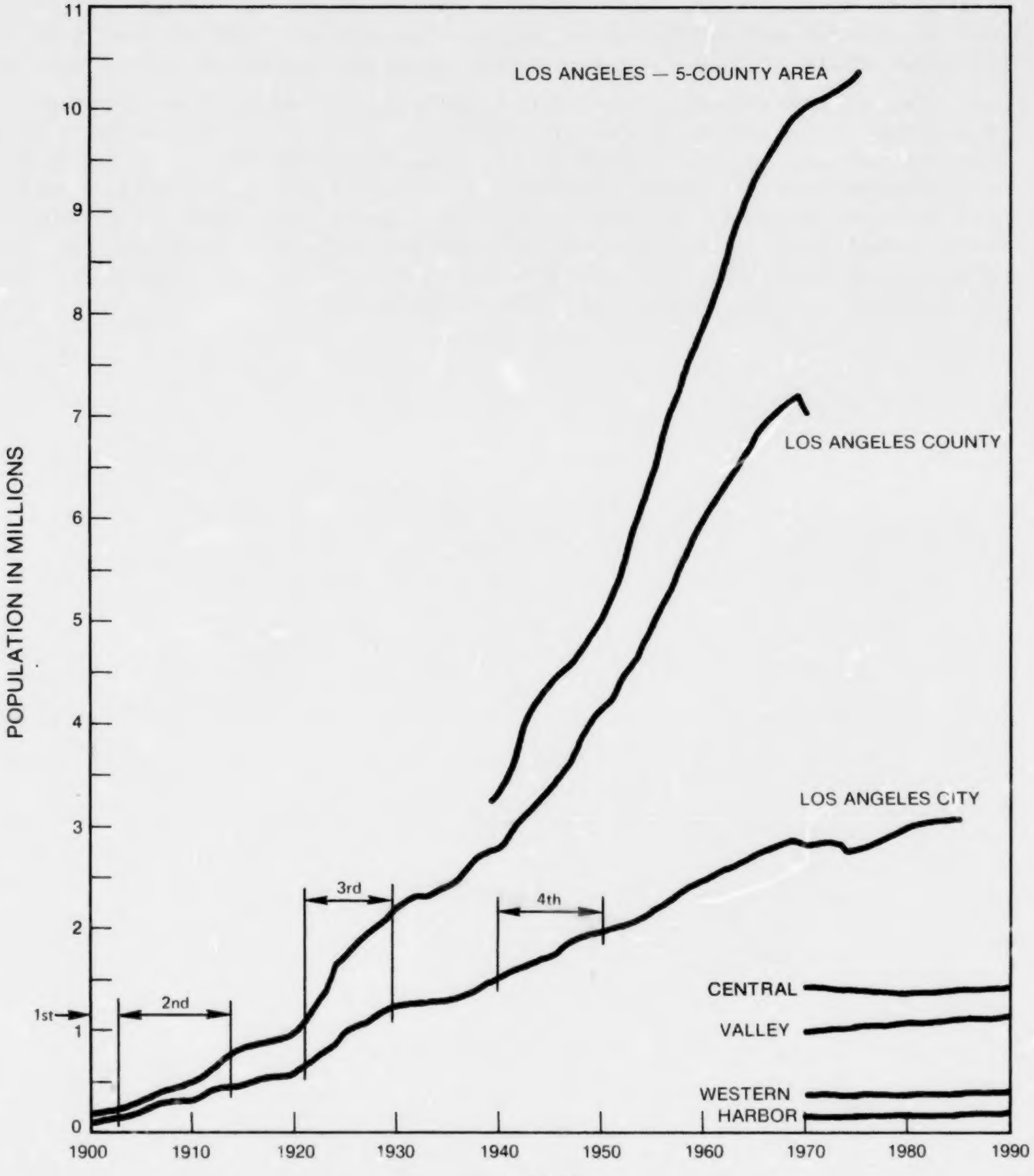

Figure V-1. Past growth in region and projected growth in the City.

D. historical importance of policies and control elements

D. HISTORICAL IMPORTANCE OF POLICIES AND CONTROL ELEMENTS

There are both temporal and spatial variables to be considered in determining cause and effect in that the determination (effect) of the causative factors is the result of a combination of many historical events (often parallel in their occurrence) and results in changes which occur at correlated points in time and location. A summary of major events is listed in Figure V-2 along with the relative population at the time. These data were then analyzed to consider population temporal dynamics through the use of empirically derived functional first derivatives describing population trends with time and second derivatives describing acceleration or deceleration of growth in order to assess the degree of correlation with each of the potential growth forces. The spatial growth of the city was then correlated with key temporal events to further determine the role of candidate growth forces as causative agents and the resulting calculations are plotted as a solid curve and displayed on Figure V-2. A general relationship can be seen on the dashed line between increased and decreased growth trends for the City of Los Angeles and the Ten Year Census of Historical Events (Figure V-2) thus encouraging additional efforts to qualify and quantify the policies and control elements that were in force at the time.

An extended hypothesis derived from such consideration is that, as this urban/industrial complex reaches its land use capacity and recycling becomes commonplace, Public Services can be used as an institutional constraint to growth thus adding an additional stage in the evolution of their role in the cause-effect relationship leading to environmental impact. Los Angeles City officials devote a large proportion of their time to considering and acting upon development proposals which substantially affect their communities in many ways. As the proposed projects increase in size, economic and environmental issues become more pronounced thus requiring a need for impact indicators. Environmental indicators are only now in conceptual stages of development. Technically, they are more like economic than social indicators in concept, in that meaningful parameters can be more readily agreed upon among developers and users.

In the main, the problem with environmental indicators is a lack of reliable historical measurement data, although there is still considerable question as to what specific form the indexes should take (Future Land Use, 1975). Recently, there has been considerable effort directed by EPA toward an integrated measure cutting across all economic, social, and environmental concerns, attempting to measure overall quality of life (QOL)

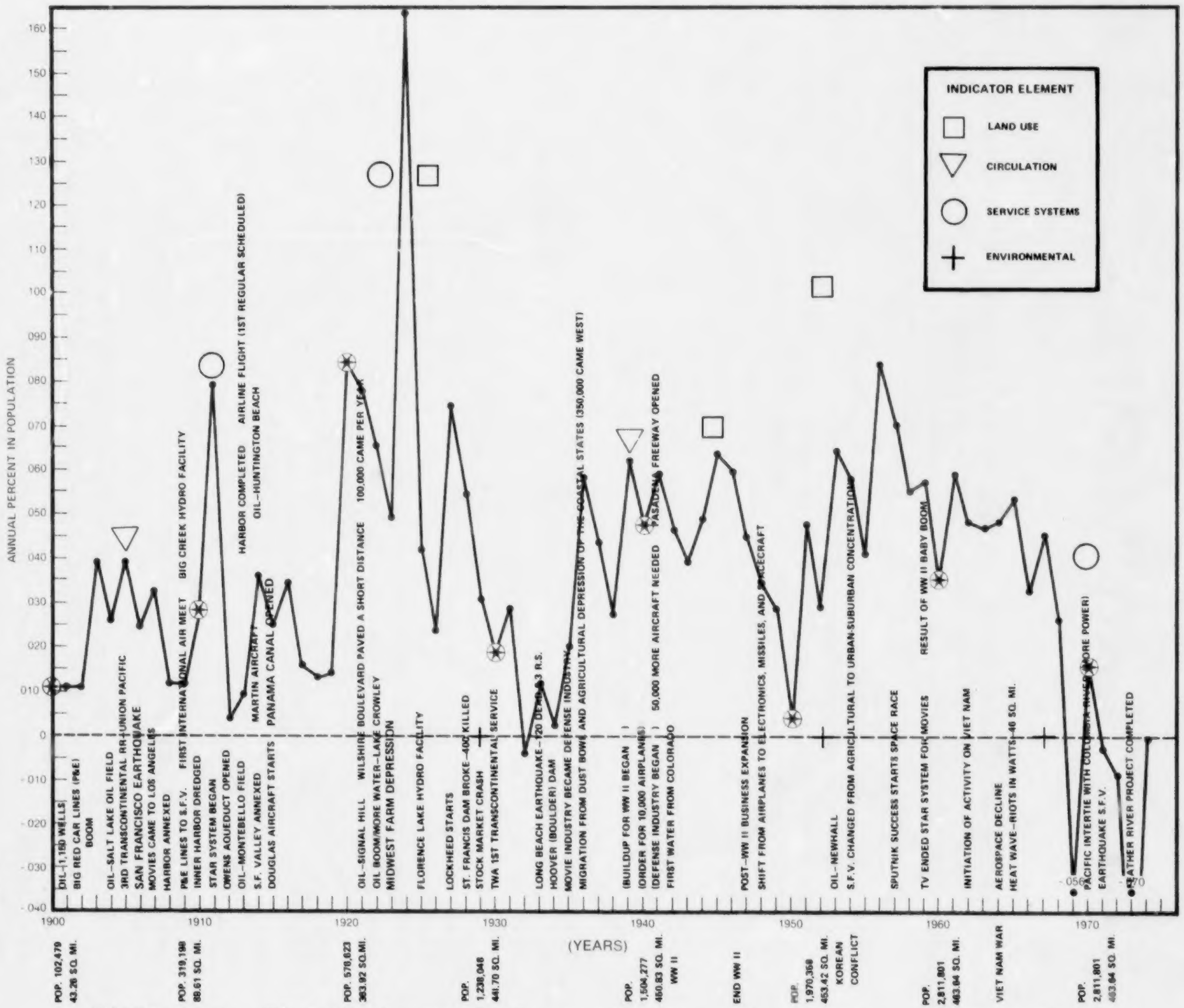

Figure V-2. Historical record of: population, major events, change in growth indicator elements for the City of Los Angeles.

of any area or group of people. As with numerous attempts to define meaningful indicators, there is little agreement within the research community on how to carry out this objective; what such a measure should include; what relationship it should have to other gross indicators; and how it can be used in a decision process.

Within the Los Angeles region, the major contributing factors to growth, and concurrently the major causes of impact have changed over the past century. In the period preceding World War I, the driving force in the growth of Los Angeles appears to be the provision of services and rail transportation. From the end of World War I until the Korean War a variety of factors including technological innovation, individual entrepreneurs and natural resources and their development were the growth shapers. Since Korea, environmental and governmental factors have been paramount in changing growth patterns, either through stimulation or discouragement. Historical patterns would suggest that a strong national economy placing emphasis upon aerospace-military technology could rapidly stimulate economic activity and lead to a more rapid rise in demand for facilities, including wastewater treatment facilities, than anticipated in SCAG-76.

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Chapter VI

basis for facilities planning

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A. introduction

VI-1

A. INTRODUCTION

1. OVERVIEW

Los Angeles, in common with all large cities, generates substantial quantities of liquid, solid, and gaseous waste products each day. If these waste products accumulate, they create substantial health, odor, and other environmental problems. Reliable, well-planned, and effective systems must therefore be established and maintained for the adequate disposal of these waste products to minimize local environmental degradation.

The purpose of this chapter is to describe the existing Los Angeles City treatment facilities for wastewater and to point out those modifications or additions which are required to satisfy local, state, and federal requirements for wastewater treatment management.

This section describes the existing facilities, their locations, management of wastewater, and treatment levels and presents the basis for the system improvements or modifications from which the alternatives in Chapter VII are derived.

Most liquid wastes have traditionally been disposed of by sanitary sewer systems. These systems handle a bewildering variety of waste products, both solid and liquid, from domestic as well as industrial sources. As a simple example, the advent and widespread public acceptance of the "garbage disposal" has tended to shift disposal of solid food wastes from the garbage can to the sewer.

Discharge of solid wastes into a sewer system does not eliminate the problem of their disposal, but does move the collection points to one or more centralized locations—the treatment plants—in place of a multitude of individual homes, businesses, and industrial facilities. Inevitably, some portion of this solid material must be landfilled - for example, the sand, particles of eggshells and bone, and other materials (grit) that are removed early in processing and are not susceptible to further treatment. Much of the remaining material (sludge), changed in form by the treatment process and relatively inert, has been discharged at sea in the Los Angeles system. However, under the provisions of federal and state regulations (see Chapter IV), this practice must be discontinued, so that land disposal of this material must also be addressed as an element of a solid waste management system. For some time, this material will be landfilled. The two systems—liquid and solid waste disposal—can thus be seen to be interactive rather than mutually exclusive.

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2. EXISTING FACILITIES

The Los Angeles City wastewater systems serve an area of approximately 600 square miles (the "Planning Area"), with a population of about 3 million. Service is provided for over 95 percent of the residents of this area, with the remainder relying on private disposal systems. The City's extensive wastewater system will require numerous construction projects in the future to accomplish three main purposes:

1. To meet the more stringent state and federal effluent requirements
2. To replace outdated and deteriorating equipment and structures
3. To accommodate minimal anticipated increases in population

Wastewater in the planning area is conveyed in a system of sewers which is separate from the storm water drainage system. There are approximately 6,000 miles of mainline sewers in the collection system, approximately 100,000 manholes, 51 pumping plants, sewer ventilation stations and various siphons and diversion structures. To maintain this system, eight sewer maintenance yards are located throughout the City.

Many of the smaller communities in the planning area have their own sewage collection systems but have no method of sewage treatment and disposal. These communities have contractual agreements with the City for treatment and final disposal of their sewage. The present flow of approximately 60 mgd is covered by these agreements.

The City's two major wastewater treatment plants are the Hyperion Treatment Plant, which services most of the planning area, and the Terminal Island Treatment Plant, which services the Harbor area. The Los Angeles-Glendale Water Reclamation Plant (LAGWRP) was scheduled to be operational in 1976. This plant will serve the Glendale and Burbank areas and a small portion of the San Fernando Valley. In addition, the City operates the Valley Settling Basin, a 1 mgd experimental treatment plant which primarily serves as a facility for research and development of wastewater treatment processes for water reclamation. The fourth treatment facility (2.5 mgd) is located at the Los Angeles Zoo and treats animal wastes. Figure VI-1 shows the locations of these treatment facilities with their collection systems.

Although the LAGWRP services the City of Burbank, Burbank owns and operates a water reclamation plant, also shown in Figure VI-1, treating a major portion of its wastewaters. The sludge generated at this treatment facility is discharged to a Los Angeles Outfall Sewer for ultimate disposal at the Hyperion Treatment Plant.

The remainder of the population served by the Los Angeles City system resides in a 20-square mile area tributary to the Terminal Island Treatment Plant (TITP). This plant, with a design capacity of 14 mgd, is located on Terminal Island adjacent to the Los Angeles Harbor. Its

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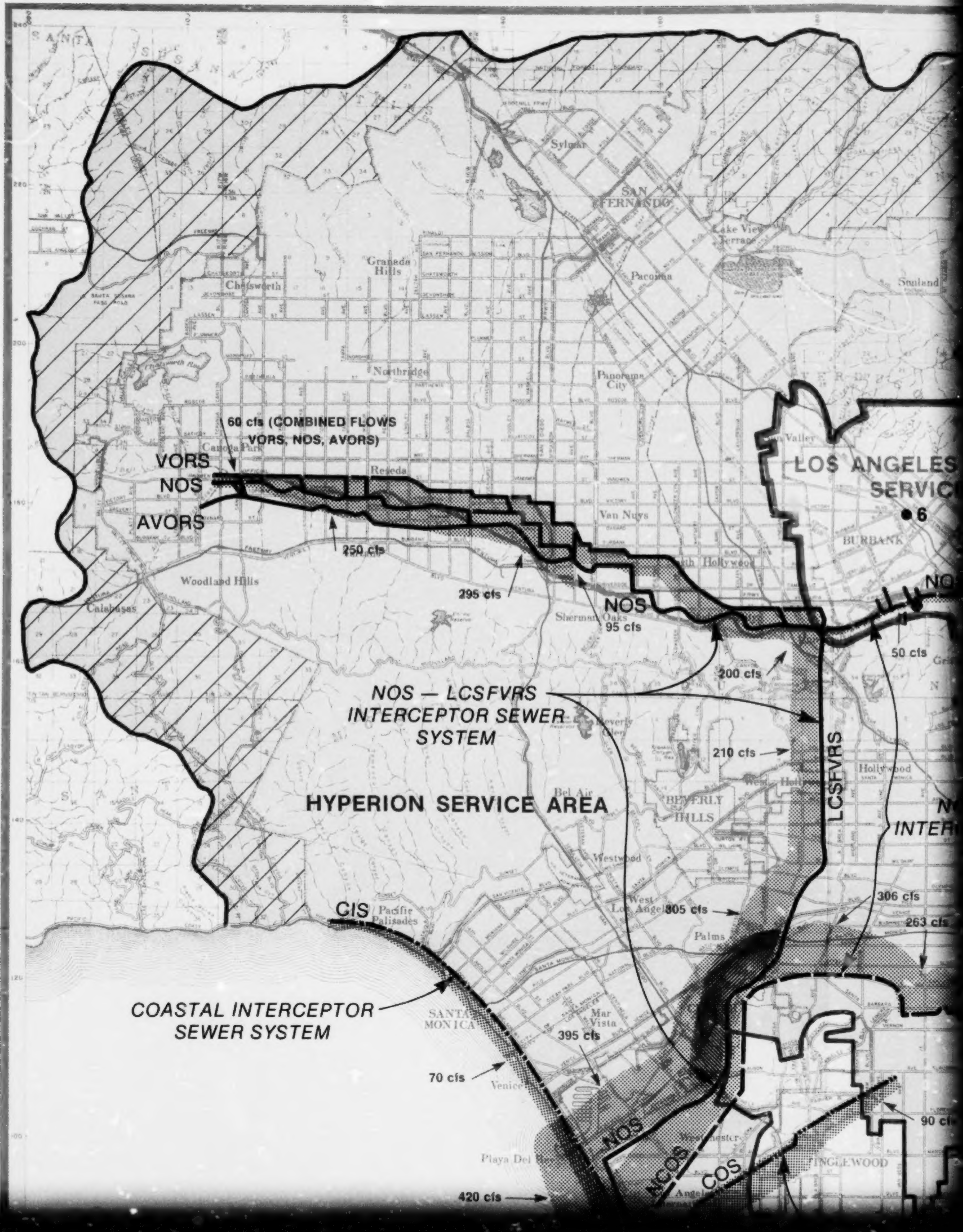

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Burbank
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Woodland Hills
Calabasas
Sherman Oaks
Beverly Glen
Hollywood
West Hollywood
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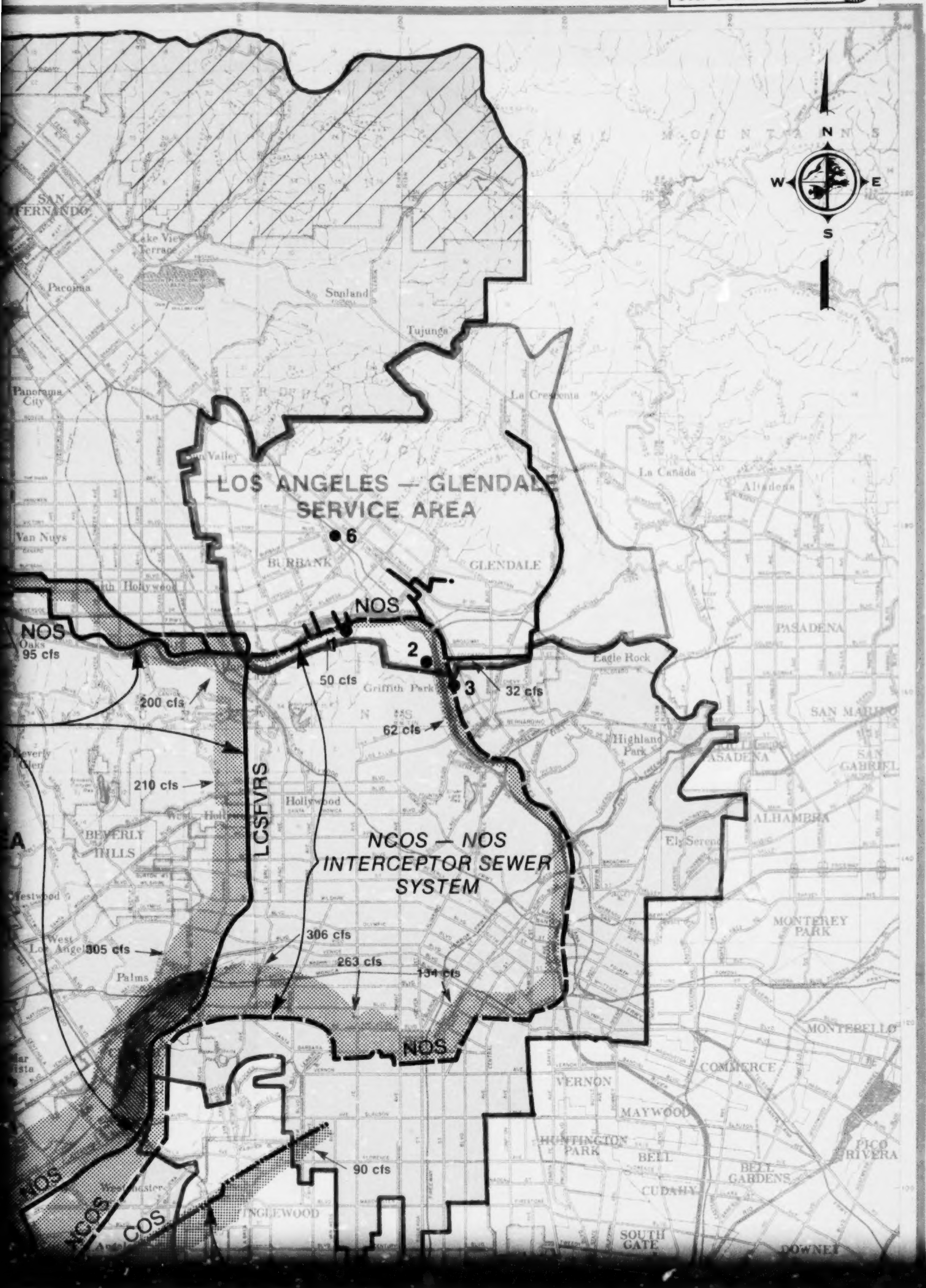
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GLENDALE
PASADENA
Eagle Rock
Griffith Park
SAN MARINO
Highland Park
SOUTH PASADENA
SAN GABRIEL
ALHAMBRA
El Sereno
Hollywood
West Hollywood
BEVERLY HILLS
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MONTEBELLO
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VERNON
MAYWOOD
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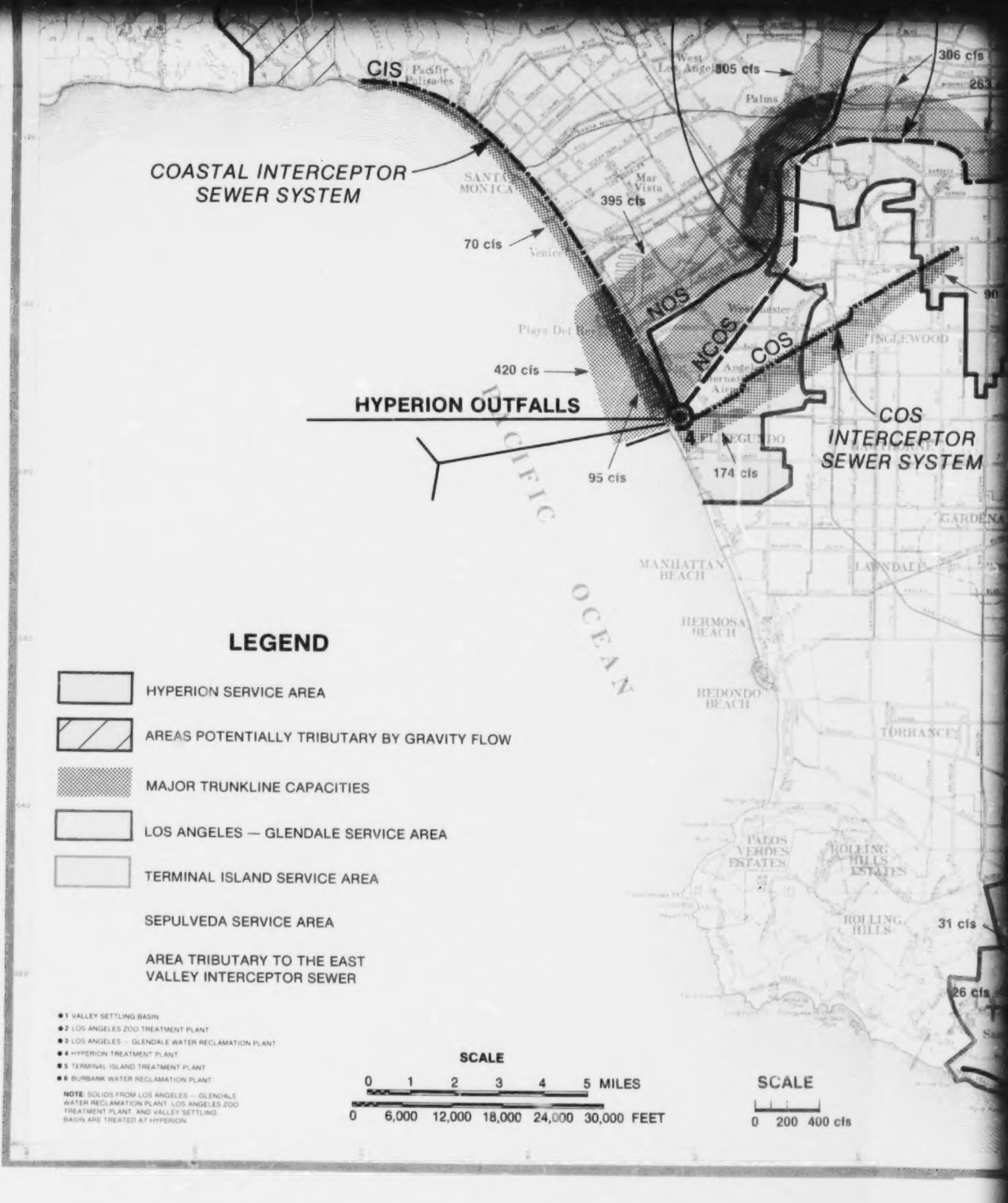
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● 1 VALLEY SETTLING BASIN
● 2 LOS ANGELES ZOO TREATMENT PLANT
● 3 LOS ANGELES — GLENDALE WATER RECLAMATION PLANT
● 4 HYPERION TREATMENT PLANT
● 5 TERMINAL ISLAND TREATMENT PLANT
● 6 BURBANK WATER RECLAMATION PLANT
NOTE: SOLIDS FROM LOS ANGELES — GLENDALE WATER RECLAMATION PLANT, LOS ANGELES ZOO TREATMENT PLANT, AND VALLEY SETTLING BASIN ARE TREATED AT HYPERION
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Figure VI-1. Treatment plant locations, service areas, and interceptor sewers.

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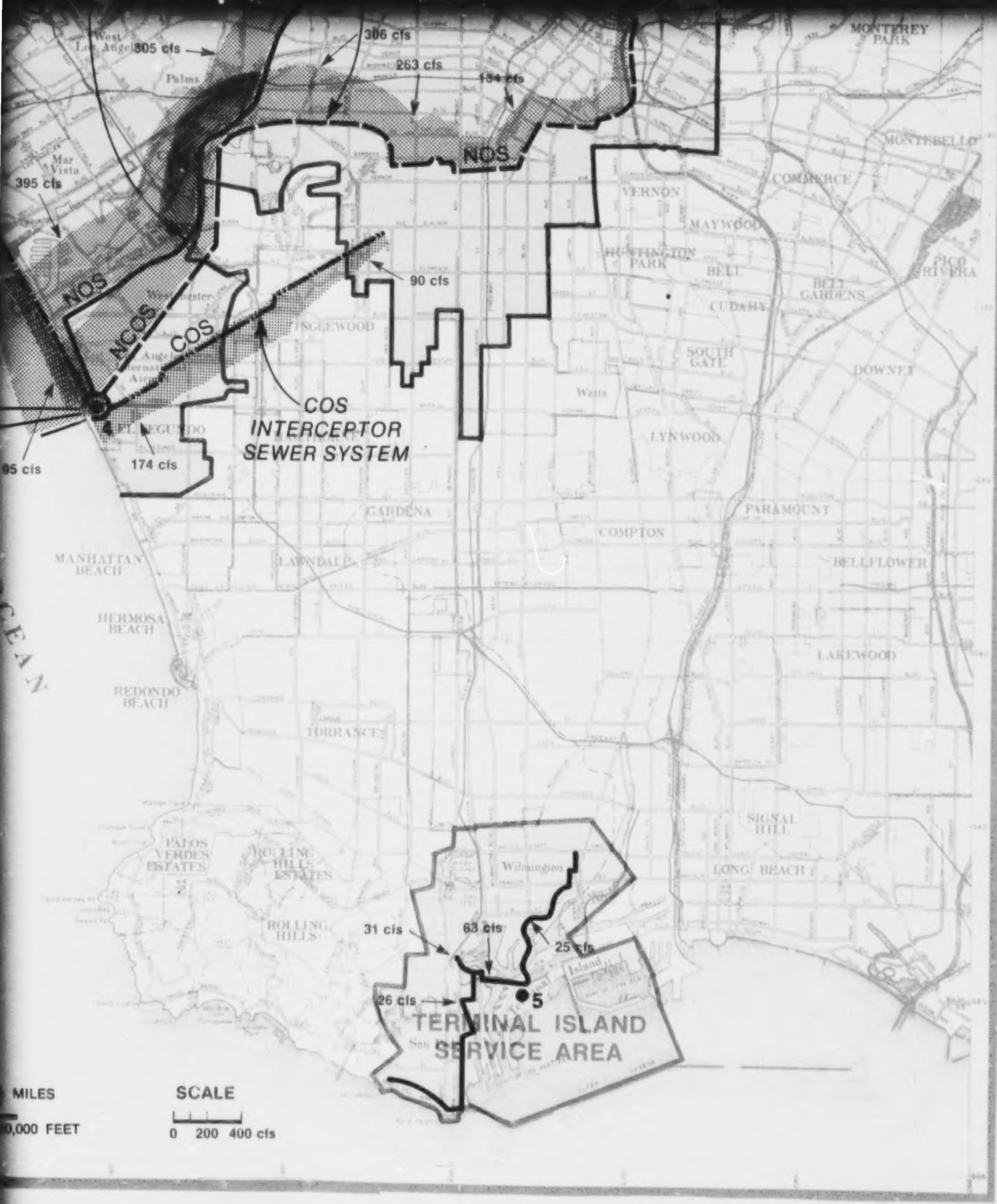
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CUDAHY
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DOWNEY
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GARDENA
COMPTON
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service area includes the communities of San Pedro and Wilmington, and much of the heavily industrialized area adjacent to the port. (The entire area is almost 50 percent industrialized.) The population of this area is approximately 115 thousand, or somewhat less than 4 percent of that in the HTP service area. TITP is currently being modernized to provide both full secondary treatment and a capacity of 30 mgd. Construction is to be completed in 1977.

Not all of the area served by the Los Angeles City wastewater system lies within the City limits. The cities of Beverly Hills, Burbank, Culver City, El Segundo, Glendale, and Santa Monica; some of the County Sanitation Districts; and Las Virgenes Municipal Water District; some unincorporated County areas, several federal facilities, and a few industrial dischargers outside the City limits have contracted for use of the City's facilities. In turn, portions of the City proper are serviced by other agencies.

3. HISTORICAL DEVELOPMENT OF PRESENT FACILITIES

The City's first sewer was purchased in 1869 from private individuals. Periodic construction projects extended the system to the south and west as the City expanded. Sewage was used without treatment for irrigation of crops.

The City's first population boom occurred between 1880 and 1900 when the City became linked to the eastern portion of the continent by the Southern Pacific and Santa Fe Railroads. During this period, the population increased from 11,000 to 102,000. By 1887, there were 20 miles of public sewer and it had become apparent that a more permanent solution to the sewage disposal problem was necessary. An 1887 report by Rudolph Herring, a New York consulting engineer, recommended an outfall to the ocean. The major consideration in selection of the Hyperion site seems to have been the favorable terrain between the City center and this location. Other factors were its remoteness from populated areas and the extensive farms of the Centinela Valley between the City and Hyperion where crop irrigation could be practiced. The outfall was completed in 1894 but by 1900 had become badly deteriorated.

In 1901, with the length of the sewer system increased to 160 miles, the City Engineer recommended construction of a new ocean outfall. Constructed with $1,000,000 in bonds voted in 1902, the Central Outfall Sewer was placed in service in 1907, and at that time crop irrigation ceased. Discharge was into the ocean at a depth of 16 feet.

It had long been apparent that lack of an adequate harbor would constrain the City's prosperity, and efforts had been made since 1870 to secure such a facility. After a long battle with the railroad interests who desired control of the harbor, the City finally completed a facility in 1914 with assistance of a congressional appropriation. A study by the Army Engineers had indicated that the Wilmington-San Pedro area was the most suitable site for a harbor; however, the site was separated from the City proper by some 20 miles. In order to control its harbor, the City was thus forced to annex both Wilmington and San Pedro and the long "shoestring strip" connecting these areas to the central portion of the City. This geographical separation accounts for the City's two separate wastewater systems.

The other major constraint to be overcome was the lack of an adequate water supply. The only water supply for the area had been surface and groundwater from the Los Angeles River Basin. It has been estimated that this supply set a practical ceiling of about 200,000 on the area's population. About 1900, City officials started purchasing water rights in the Owens Valley. Following numerous legislative and legal battles, the City won the right to import these waters, and in 1913 the 233-mile Owens Aqueduct was completed. The City's ownership of this water supply resulted in the annexation of many smaller cities and nearly the entire San Fernando Valley to the City of Los Angeles since these areas could not otherwise obtain adequate water. Ultimately, this probably resulted in one treatment plant, Hyperion, serving most of the area's population instead of a multiplicity of small plants owned by individual municipalities. The Owens Aqueduct ultimately became inadequate and today, Colorado River water, a second Owens Aqueduct and Feather River Project water all supply water to the Los Angeles Basin.

By 1920, the City's population had increased to 576,000 and the Central Outfall Sewer was nearing capacity. During rainy periods, sewage overflowed to the streets at many locations. After several attempts, a bond issue for sewerage system improvements passed in 1922. With this money, the City built a submarine outfall sewer, a screening plant at Hyperion, and the North Outfall Sewer from Hyperion to its upper terminus in the westerly end of the San Fernando Valley (see Figure VI-2).

The screening method of treatment instituted at that time sufficed for awhile; however, problems became apparent in the form of sewage odors, discoloration and grease along the beach north and south of Hyperion. In April, 1943, the State Board of Health quarantined 10 miles of beach from Hermosa Beach to Venice. As a result of this action, the consulting firm of Metcalf and Eddy was hired to investigate and recommend a solution. From the recommendation of the report, design of a full secondary treatment plant utilizing the high rate activated sludge system plus digestion and sludge drying facilities ensued. By 1950, most of these facilities had been constructed and were in operation. A one-mile long, 12-foot diameter reinforced concrete ocean outfall was constructed for the discharge of the plant effluent away from the beach at a depth of 50 feet (Figure VI-3).

Unfortunately, these facilities shortly proved inadequate. Significant population growth necessitated the construction of the west headworks and primary tanks to provide additional capacity. The threat of beach contamination required the construction of a five-mile effluent ocean outfall, which has been in use since 1961 (Figure VI-3). This

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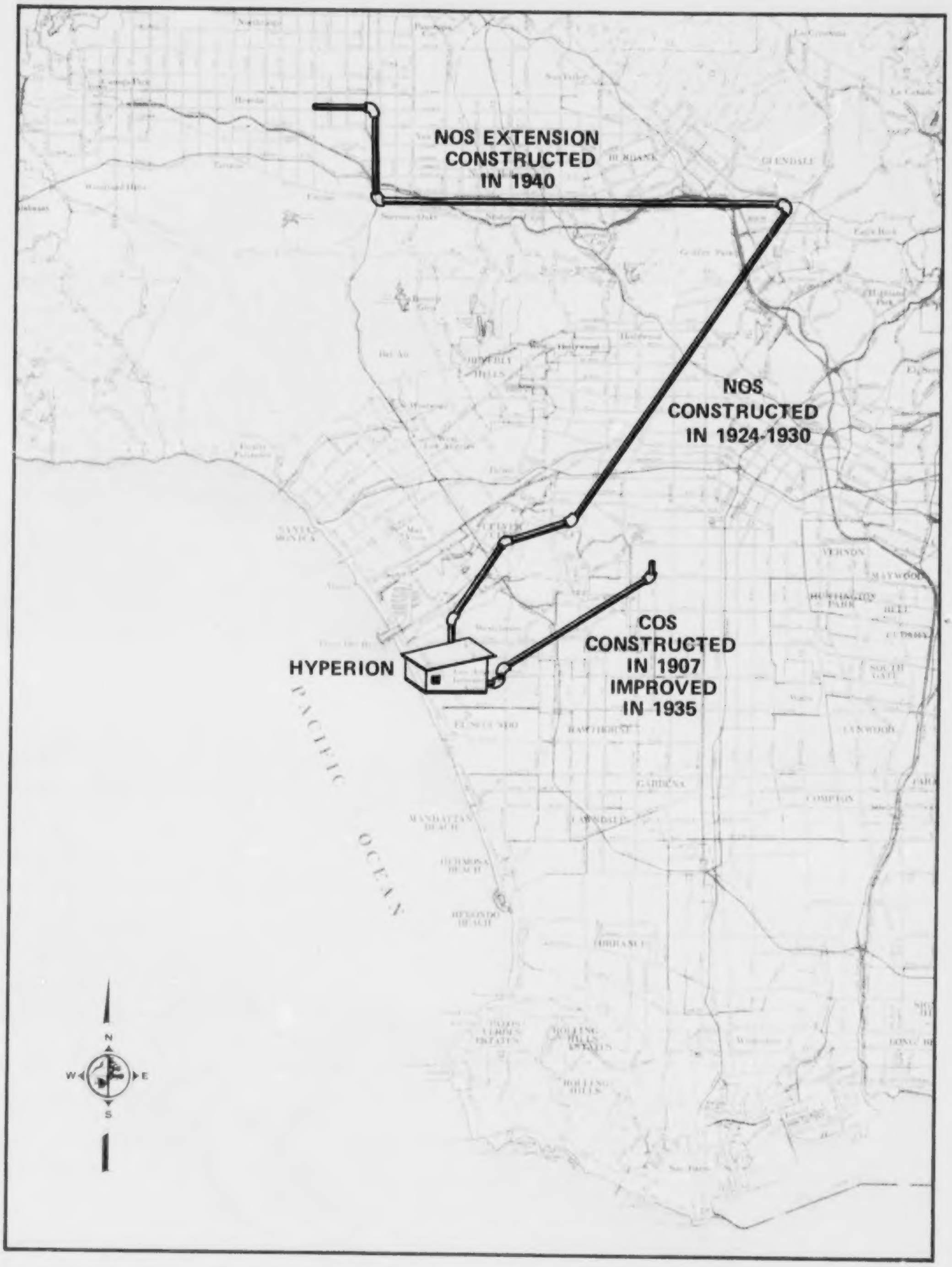
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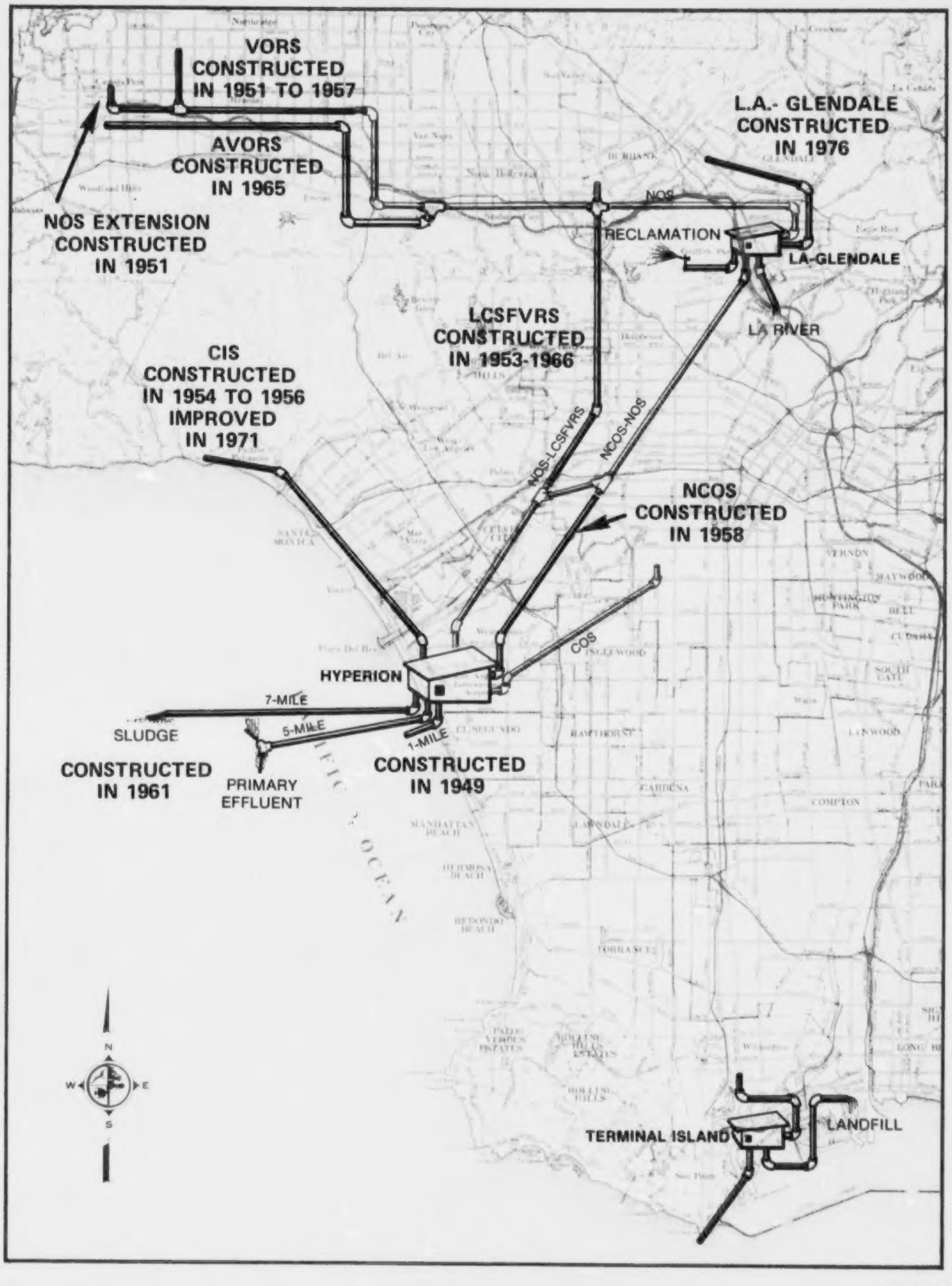
Figure VI-2. Pre-World War II Los Angeles wastewater treatment system.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IN 1958
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5-MILE
1-MILE
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CONSTRUCTED
IN 1961
PRIMARY
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LANDFILL
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198P–53

Figure VI-3. Post-World War II Los Angeles wastewater treatment system.

conduit, 12 feet in diameter, discharges at a depth of 180 feet. The operational mode of the plant was changed at this time to provide 100 mgd standard rate activated sludge treatment and up to 420 mgd primary treatment. The mixed primary standard rate effluent was essentially similar to that of the high rate process and much easier to control. The standard rate mixed liquor also provided biological filtering of odorous gases.

In an effort to recycle the digested solids, a fertilizer plant was built in 1950; however, this proved to be a source of air pollution. In addition, the solids in excess of fertilizer plant capacity were discharged into shallow near-shore waters, creating a source of water pollution. The plant was uneconomical to operate; consequently, a 20-inch diameter sludge outfall was constructed and the fertilizer plant was shut down. The sludge line discharged at the head of a submarine canyon at a depth of 320 feet and 7 miles to sea. This was considered to be the best environmental alternative at that time (see Figure VI-3).

The present status of the Hyperion Treatment Plant is detailed later in this chapter.

The Los Angeles harbor area (basically comprising the communities of Wilmington and San Pedro), being geographically separated from the rest of the City, has been provided with a completely separate wastewater system and treatment facility at Terminal Island. Initially, effluent was discharged directly to the ocean following screening, which created nuisance conditions.

During the thirties, a study was conducted to determine an improved method of disposal. This study resulted in the construction, between 1934 and 1936, of a primary treatment plant with an ocean outfall to discharge the effluent several hundred feet away from the shoreline. The sludge was digested and placed in beds to dry after which it was hauled away.

In 1950, the firm of Metcalf and Eddy was retained to conduct a study and recommend a method of treatment and disposal of sewage in the harbor area. The report recommended that the primary treatment capacity of the plant be increased. Also recommended was the construction of a 39-inch RCP effluent outfall extending 458 feet into the outer harbor. Both recommendations were subsequently put into effect.

However, a concentration of industry in the harbor area since World War II has resulted in large quantities of industrial waste being discharged into the inner and outer harbor waters. These practices have continually increased serious pollution problems.

The Terminal Island Treatment Plant is presently being upgraded to a 30 mgd secondary treatment plant in order to meet present water quality requirements.

In April 1961, the citizens of the City, through passage of the 1961 Sewer Bonds, provided for a comprehensive study of the City's sewerage system. The initial study, published in 1966, but essentially completed several years earlier, emphasized the provision of additional capacity at the Hyperion Treatment Plant. Five alternative schemes were studied, all featuring different strategies for relief of trunk sewers carrying flow to Hyperion.

By the late-1960s, it appeared that upstream treatment plants offered advantages over the previous strategy of additional capacity at Hyperion and the City's policy in this regard shifted accordingly. A report, *Reclamation of Wastewater, City of Los Angeles*, issued in October 1968, showed the feasibility of this concept (see Addendum #1).

In 1975 the City of Los Angeles began preparation of an updated Facilities Plan with a series of alternative projects whose relative merit was to be determined and associated environmental impacts quantified. This report is one step in that evaluation process.

4. PLANNING AUTHORITY, ORGANIZATION, AND PROCEDURE

The planning agency and owner of the treatment facilities involved in the planning process is the City of Los Angeles. The City Charter empowers the City Council to provide sewers and appurtenances for sanitary purposes in order to promote the peace, health, safety, and welfare of the public.

The actions and programs developed in the Los Angeles Facilities Plan are for the most part legislatively mandated. The two basic laws are PL 92-500, the Federal Water Pollution Control Act Amendments of 1972, and the California State Porter-Cologne Water Quality Act of 1970. Pursuant to the Porter-Cologne Act, the State Water Resources Control Board (SWRCB) has adopted directives which affect wastewater planning. The State's *Water Quality Control Plan for Ocean Waters of California*, known as the *Ocean Plan*, establishes detailed limits on concentrations of constituents which may be discharged to ocean waters and establishes objectives to enhance and maintain their quality. In the *Water Quality Control Plan for Control of Temperature in the Coastal and Interstate Waters and Enclosed Bays and Estuaries in California*, known as the *Thermal Plan*, the SWRCB specifies limiting temperatures in wastewaters discharged to those waters. The *Water Quality Control Policy for Enclosed Bays and Estuaries of California*, known as the *Bays and Estuaries Policy*, establishes the SWRCB policy that discharges of municipal and industrial wastes into those waters shall be phased out unless they enhance water quality. The Regional Water Quality Control Board's *Basin Plan* incorporates federal and state legislative mandates and state plans and policies in establishing objectives for waters in the Los Angeles River Basin. The Facilities Plan must be in conformance with all requirements applicable to waters in the planning area.

As a consequence of these laws and plans, two major modifications of the existing system are required. First, the SWRCB and EPA have determined that the City must discontinue the discharge of sewage sludge to the ocean. Second, the City must provide full secondary treatment for all wastewaters discharged to receiving waters to comply with PL 92-500. The Facilities Plan and this EIS consider these matters in detail. In addition, numerous other alternatives are considered. Prominent examples are whether to locate additional treatment capacity upstream with discharge to the Los Angeles River or downstream at the Hyperion site with ocean discharge, the potential for water reclamation, methods for source control, and the significance of inflow and infiltration in the system. These matters are elements which are common to all plans.

The Department of Public Works, which administers the water pollution control policy, is headed by the Board of Public Works. This Board is composed of five full time, salaried members and has jurisdiction over 12 Bureaus. Of these Bureaus, the Bureau of Engineering is responsible for planning and designing public works facilities and is therefore directly responsible for this facilities plan, and the Bureau of Sanitation is in charge of operation and maintenance of sewage collection and treatment facilities, as well as refuse collection and disposal.

Other City agencies involved in the planning process are the Department of City Planning, Recreation and Parks, and Water and Power. A function of the Department of City Planning is population projections, prime parameters used to determine the extent of future facilities planning. The Department of Water and Power's responsibility is to regulate and control the use, sale, and distribution of water in the City. This Department has implemented numerous studies relating to the feasibility of using reclaimed water, and these studies are continuing. The Department of Recreation and Parks would initially be the prime user of reclaimed water and has, thus, also been directly involved in wastewater planning.

Outside agencies involved in the planning process have been the agencies which contract with the City for sewerage services. Raw and treated wastewater, which they discharge to the City's system, must fully meet all requirements the City imposes upon its own dischargers.

a. Section 201, Facilities Plans. A Facilities Plan is required by EPA Rules and Regulations, Section 35.917, to satisfy the structures of Section 201, PL 92-500, that grant applicants demonstrate that adequate studies have been made. "Facilities planning will demonstrate the need for the facilities, and, by a systematic evaluation of feasible alternatives, will also demonstrate that the proposed measures represent the most cost-effective means of meeting established effluent and water quality goals, and recognizing environmental and social considerations." As effectuated by the City of Los Angeles, the Facilities Plan will serve as the 25-year plan for wastewater projects serving the City's planning area.

The problem of ultimate sludge disposal, while properly a part of the Facilities Plan, is not resolved in this plan. A three-year regional study is currently underway as a cooperative project of the City, the Los Angeles County Sanitation Districts, the Orange County Sanitation Districts, State Water Resources Control Board, and the Environmental Protection Agency. The results of this sludge study will be incorporated into future revisions of the Facilities Plan. However, a proposed interim project to alleviate the present sludge discharge will be considered.

b. Institutions Affecting Wastewater Facilities Planning. The planning area contains a number of institutions which are directly or indirectly involved with wastewater facilities planning. All the cities within the planning area have their own planning departments which provide population and land use data. Each city estimates wastewater outflow and contracts with the City of Los Angeles for disposal. The Cities of Burbank and Glendale are directly involved in the wastewater treatment process through independent or joint operation of facilities to treat portions of their wastewater flow. Although these cities contribute to the facilities planning process, the primary planning responsibility is with the City of Los Angeles.

(1) CITY OF LOS ANGELES. The City of Los Angeles' Department of Public Works, Bureau of Engineering, and Bureau of Sanitation are charged with the responsibility of the wastewater program of the City. Specifically, the Bureau of Engineering's Wastewater Systems Engineering Division is responsible for the planning and design of all wastewater facilities belonging to the City while the Bureau of Sanitation is responsible for the operation and maintenance of those facilities. Both Bureaus cooperate with each other. Most of the technical material in this chapter was provided by the Bureau of Engineering and the Bureau of Sanitation. In particularly technical information on treatment plant operation, sanitary landfills, industrial wastes, and ocean biology were provided by the Bureau of Sanitation.

Although not directly involved in the technical aspects of wastewater facilities, the City's Department of City Planning provides data important to the planning process. Their Planning Systems Section is intimately involved with population, zoning and land use on a citywide and local basis. Much of the material in this report was provided by the Department. In addition, the conclusions reached in the approved report will assist the Department in preparing the Wastewater Systems Plan of the City's General Plan for adoption by the City Council.

Other City departments indirectly involved with wastewater facilities are the Departments of Water and Power, and Recreation and Parks. The Department of Water and Power provides water to most of the planning area and, as such, affects the mineral content of wastewater effluent and can affect the quantity of water treated through water cost-versus-demand relationships. The Department of Recreation and Parks will be involved by the use of reclaimed water from LAGWRP for irrigation in Griffith Park and possible reclaimed water use in other areas depending upon the conclusions made in this report. The Department of Water and Power may also be involved in the future with the use of reclaimed water in their steam power plants.

The City Council itself is the final city authority with respect to all City projects. Funding for facilities construction and even for the preparation of this report is the direct responsibility of the City Council. The Council must adopt the Facilities Plan report and the recommendations herein before the Facilities Plan can become the official position of the City.

(2) THE COUNTY OF LOS ANGELES. Because of the irregular boundaries of the City of Los Angeles and the metropolitan areas surrounding it, the County of Los Angeles plays an important role in coordinating needed services. In addition to the County treatment facilities previously mentioned, the County provides for the disposal of the majority of solid wastes in the County. These two essential services are under the jurisdiction of the County Sanitation Districts which also conduct, coordinate and participate in waste and wastewater studies in treatment processes and disposal methods. The Los Angeles County Flood Control District is involved in storm water runoff, storage, and debris facilities.

The Los Angeles County Regional Planning Commission is the official planning agency for all unincorporated County areas and provides overall regional planning for Los Angeles County. It recommends development guidelines and reviews development proposals. While it is not specifically involved in wastewater planning, it provides population and land use projections used by cities and the County agencies.

(3) REGIONAL INSTITUTIONS. On the regional level, the Southern California Association of Governments (SCAG) is the lead agency responsible for coordinating areawide water, sewer, and flood control planning. It is the designated Regional planning organization certified by the Federal Department of Housing and Urban Development. In addition to the County of Los Angeles, SCAG has jurisdiction over the Counties of Ventura, Riverside, San Bernardino, Orange, and Imperial. SCAG plays a major role in the allocation of population between counties and statistical areas in making population estimates and projections.

Also indirectly involved on the regional level is the Southern California Air Pollution Control District Los Angeles Zone. This agency can influence wastewater facilities funding, if not their construction, by establishing construction restrictions, or influencing other agencies to limit funding to existing population levels or for limited population projections.

Although not involved in the planning process, the South Coast Regional Zone Conservation Commission has jurisdiction over construction within the Coastal Zone established under the Coastal Zone Conservation Act of 1972. As such, it has control over any major construction that might be proposed at either Hyperion or TITP.

(4) FEDERAL AND STATE INSTITUTIONS. Agencies on the federal level involved with local planning include the Army Corps of Engineers, the Environmental Protection Agency (EPA), the Department of Agriculture (USDA), the Department of Housing and Urban Development (HUD), the Department of Interior (DOI), and the Water Resources Council. The federal agency most directly involved locally is the EPA which promulgated many of the environmental regulations with which the City must comply.

On the state level, the major agencies include the State Water Resources Control Board (SWRCB), their Regional Water Quality Control Board, Los Angeles Region (SWQCB), the State Department of Water Resources (DWR) — the Office of Planning and Research, the Department of Navigation and Ocean Development, the California State Coastal Commission and the California Air Resources Board. The SWRCB is of major concern to the Facilities Plan approval as they are directly involved in establishing guidelines and criteria for the facilities planning process and must ultimately approve the City's Facilities Plan prior to allocation of state and federal funds.

5. DEVELOPMENT OF TREATMENT REQUIREMENTS AND FACILITY NEEDS

The ocean discharge requirements for the Terminal Island and Hyperion Treatment Plants are based on those in the *Basin Plan* and *Ocean Plan*.

The Hyperion Treatment Plant system has the primary effect upon the ocean waters from the service area. This system treats 95 percent of the wastewater generated within the City of Los Angeles and the various contractual communities. Currently, the Hyperion System discharges a blend of primary and secondary treatment effluent by means of a 5-mile outfall and discharges digested sludge by means of a 7-mile outfall.

Projects that have been approved for grant funding or are already under construction to upgrade the Hyperion system include the LAGWRP and miscellaneous improvements at Hyperion. The LAGWRP will provide for better than full secondary treatment and will discharge sludge back into the sewer system for treatment at Hyperion. The elimination of sludge discharge to the ocean is required by both the EPA and the SWRCB.

In furtherance of meeting discharge requirements, the Facilities Plan provides for the upgrading of the Hyperion Treatment Plant to provide for full secondary treatment. When the full secondary treatment facility becomes operational, and if adequate source controls for cyanide, nickel and mercury are enforced, all of the objectives set forth in Tables VA-1 and VA-2 of Appendix V will be met, except for the total chromium concentration. The chromium concentrations cannot be decreased to meet the

0.005 mg/l State Standards even with the best practicable methods of source control. Domestic contributions alone are in the order of over 30,000 pounds per year. This does not arise from practical controllable point sources, and the compounds which contribute to the total and which can be legislatively banned are not readily evident. Treatment will remove a majority of the chromium; however, experience with high grade activated sludge effluent indicates that about 16 percent will remain in the water to be discharged. Effluent concentrations from such uncontrollable domestic sources are expected to be a minimum of approximately 13 pounds per day or 0.005 to 0.006 mg/l.

Source control through the Industrial Waste Permit procedure will reduce present industrial concentrations of chromium by 90 percent. The remaining 10 percent amounts to approximately 38,000 pounds per year. A further 84 percent removal is expected by activated sludge treatment leaving about 6,100 pounds per year of chromium in the effluent from controlled industrial sources. This represents an additional concentration of 0.006 mg/l, producing a minimum total effluent concentration of 0.011 to 0.012 mg/l of chromium.

Mercury probably could be adequately controlled through better regulation at hospitals. If additional source controls for mercury are not established and enforced, Hyperion secondary effluent may not meet existing state standards for mercury.

The discharge of primary treated wastewater is presently in effect through the Terminal Island Treatment Plant outfall to the Outer Harbor of the Los Angeles Harbor. Other significant dischargers are the various harbor related industries which discharge untreated wastewater directly into the harbor waters. (In this respect, the facilities planned by the City of Los Angeles are expected to fulfill the objectives set forth in Tables VA-1 and VA-2 of Appendix V.)

Construction of Phase I of the Terminal Island Treatment Plant (TITP) was scheduled for completion in 1976. Phase IIA has received concept approval. Upon completion of these phases, the TITP will provide for full secondary treatment of wastewater and sludge disposal at a landfill site. Furthermore, completion of the ongoing Harbor Collection System in which sewers will be tributary to TITP, will totally eliminate the direct discharge of industrial wastewater into the harbor. It is expected that the completion of the collection system and TITP will result in treatment of all discharges in conformance with the objectives, with the exception of the chromium concentration limits as mentioned previously.

There is one location within the City of Los Angeles where major sewer overflows have occurred intermittently. Large peak flows at the Hyperion Treatment plant during high intensity rain storms can be accompanied by overflows at an overflow structure in the North Outfall Sewer at Jackson Avenue, just north of the intersection of Overland Avenue and Jefferson Boulevard, in Culver City. This overflow is necessary to protect the

North Outfall Sewer from being subjected to excessive pressure which may cause it to burst. The resulting overflow is into Ballona Creek, an improved watercourse which terminates 5 miles downstream in Santa Monica Bay. It is the intent of the plan to construct and improve facilities to eliminate or substantially reduce overflows into Ballona Creek. The impacts on the environment due to these overflows are discussed in Chapter VIII, Primary Impacts.

B. description of existing wastewater facilities

B. DESCRIPTION OF EXISTING WASTEWATER FACILITIES

1. TREATMENT PLANT LOCATION AND COLLECTION SYSTEM CONFIGURATION

a. Hyperion Treatment Plant.

(1) LOCATION. The Hyperion Treatment Plant (HTP) is located on a 144-acre site adjacent to the Pacific Ocean and southwest of the Los Angeles International Airport. The treatment plant location, its main collection system, and the plant's present service area are shown in Figure VI-1. Figure VI-4 is an aerial view of the plant.

(2) OUTFALL SYSTEMS. The Hyperion Plant is serviced by three ocean outfalls (1-mile, 5-mile and 7-mile) as indicated in Figure VI-5. The 1-mile outfall is a 12-foot-diameter concrete line, which was placed in service in 1949 concurrently with the activated sludge treatment facilities. This line has not normally been in use since the 5-mile outfall was placed in service but is maintained in a standby condition in case of an emergency.

The 5-mile outfall is the City's major effluent disposal conduit. It was put into service in 1961 as a result of a 1957 study which essentially concluded that deep ocean disposal of primary effluent would be just as effective and economical in alleviating beach pollution as would the enlargement of the activated sludge facility. The outfall consists of a 12-foot-diameter reinforced concrete pipe (RCP), a wye structure, and two diffuser legs. The present structural condition of the outfall is excellent and no problems have been experienced.

The 7-mile outfall was constructed as a result of a comprehensive study completed in 1957 in which it was concluded that pumping of sludge to the ocean and disposing of it at a depth of 320 feet at the head of a submarine canyon would be more economical than continuing to utilize the digested sludge for fertilizer. It is proposed to terminate the disposal of sludge to the ocean as mandated by the State of California Water Resources Control Board and the United States Environmental Protection Agency. This outfall would then be reserved for emergency use. The impacts both of the discharge of these materials into the ocean and of the modification or cessation of such discharges are one of the most important environmental concerns that must be addressed with respect to the Facilities Plan. They are treated in detail in Chapters III and VIII of this report.

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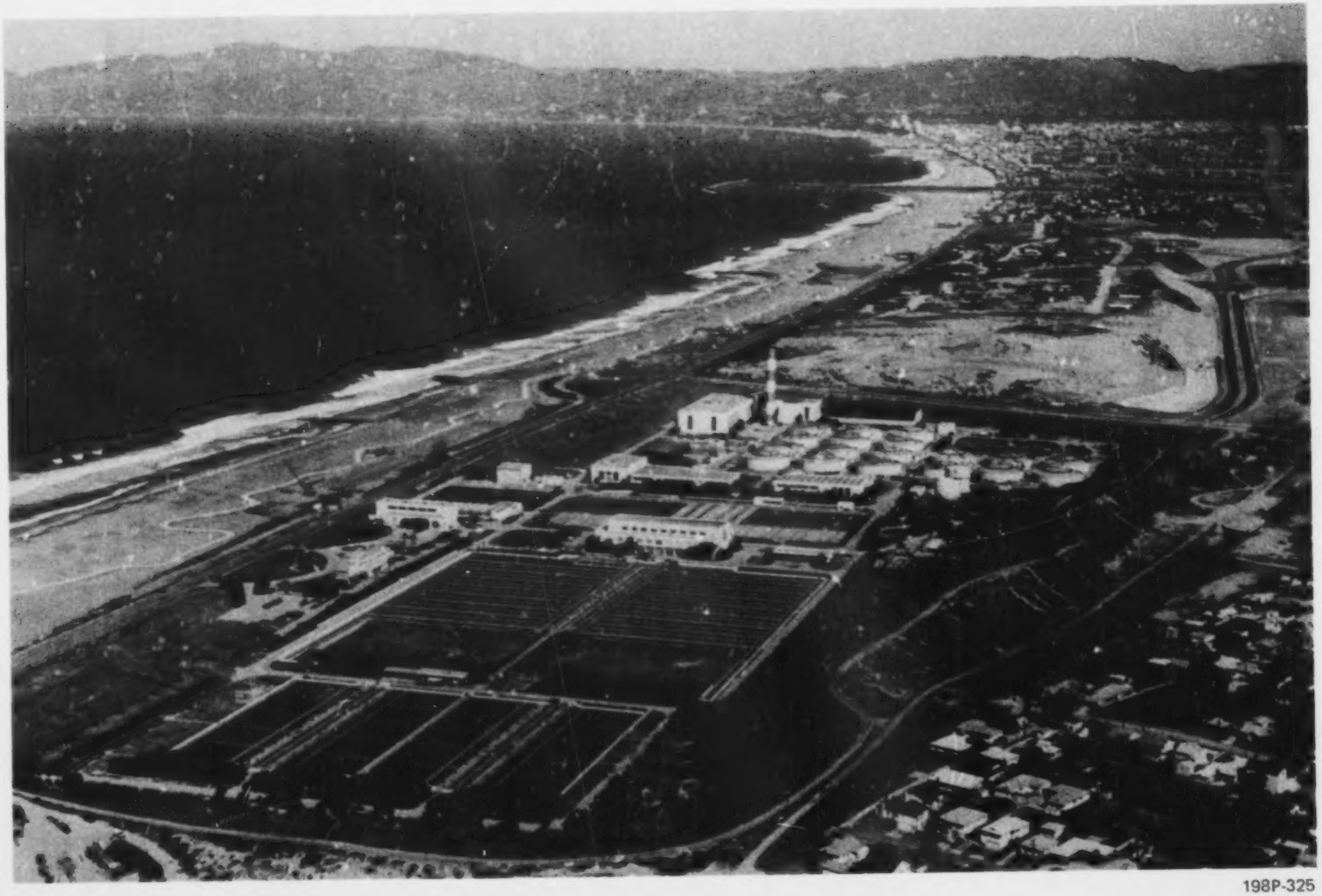

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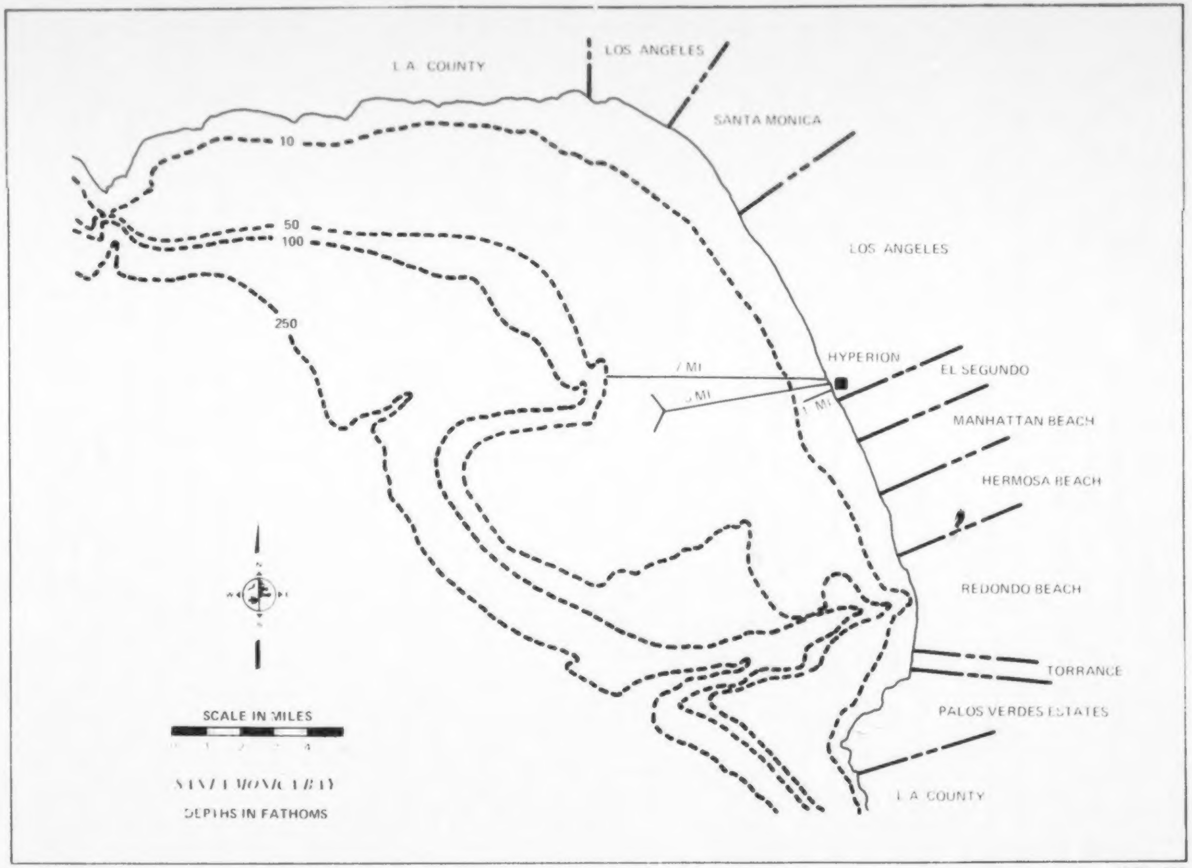
Figure VI-4. Aerial view of the Hyperion Treatment Plant.


L A COUNTY
LOS ANGELES
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MANHATTAN BEACH
HERMOSA BEACH
REDONDO BEACH
TORRANCE
PALOS VERDES ESTATES
L A COUNTY
10
50
100
250
7 MI
5 MI
1 MI
SCALE IN MILES
0 1 2 3 4
SANTA MONICA BAY
DEPTHS IN FATHOMS

198P-326

Figure VI-5. Effluent (1- and 5-mile) and sludge (7-mile) outfalls servicing the Hyperion Treatment Plant.

(3) SERVICE AREA. The City of Los Angeles provides sewage services for most of its corporate area and for several other cities and unincorporated areas. The excluded areas are the "shoestring strip," connecting the Harbor area to the remainder of the City, the Watts area and several small "islands" north of Inglewood served by County Sanitation Districts. A vast network of sanitary sewers extends over approximately 513 square miles of the metropolitan area to collect wastewater and convey it to the Hyperion Treatment Plant for treatment and disposal.

The various governmental agencies within the Basin have worked well together in providing each other with sewage service. Figure VI-6 is a map showing the service areas within the City.

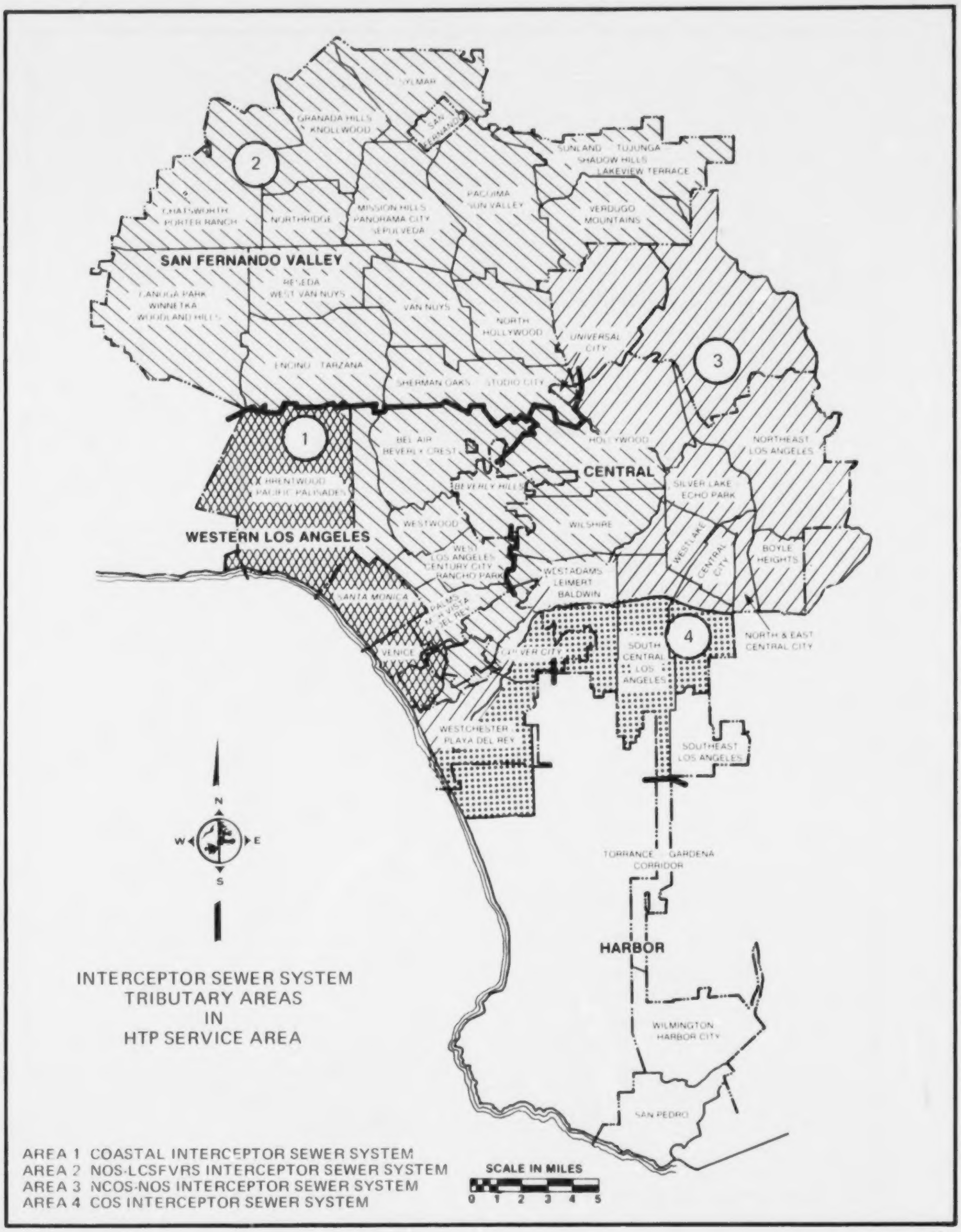
Los Angeles County's Joint Water Pollution Control Plant (JWPCP) is of comparable size to the HTP in terms of quantity of sewage treated. The JWPCP is located in the City of Carson at the northwesterly corner of the intersection of Figueroa Street and Lomita Boulevard and generally serves all areas westerly of the San Gabriel River and southerly of the City of El Monte not served by HTP or TITP. Included in its service area are portions of Watts, the City's shoestring strip, a portion of San Pedro and several City areas adjacent to Inglewood.

Northerly of the JWPCP is the County's Whittier Narrows Water Reclamation Plant (WNWRP). Its service area generally includes El Monte and all other areas northerly and westerly of the San Gabriel River not served by HTP or LAGWRP. WNWRP became operational in 1962 and is the first upstream treatment plant in the Basin providing reclaimed water for irrigation, recharge and other uses.

The Las Virgines Municipal Water District (LVMWD) adjoins the westerly boundary of the HTP Service Area in the San Fernando Valley. Portions of the District are presently being served by HTP and several small areas are included in the Hyperion system planning areas in Los Angeles and Ventura Counties including the Triunfo CSD of Ventura County which abuts the HTP Service Area's westerly boundary.

The drainage area serviced by the Hyperion Treatment Plant is approximately 328,000 acres (513 square miles) of the greater metropolitan area. This total area includes 53,000 acres outside the City of Los Angeles which are tributary to Hyperion under contractual agreements with other governmental agencies. In addition to providing treatment for most of the City of Los Angeles, Hyperion receives flows from Beverly Hills, Santa Monica, Culver City, El Segundo, San Fernando, Burbank, Glendale, and unincorporated areas of Los Angeles County. There is also a future area consisting of all areas potentially tributary by gravity to the Hyperion Treatment Plant System, as shown in Figure VI-7.

(4) CONTRACTUAL AGENCIES. The contractual agencies which discharge their wastewater to the HTP are listed in Table VI-1. The table also states their contractual rights and estimated present flows. The locations of these agencies are shown on Figure VI-8.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NORTHRIDGE
MISSION HILLS PANORAMA CITY SEPULVEDA
PACOIMA SUN VALLEY
VERDUGO MOUNTAINS
SAN FERNANDO VALLEY
CANOGA PARK WINNETKA WOODLAND HILLS
RESEDA WEST VAN NUYS
VAN NUYS
NORTH HOLLYWOOD
UNIVERSAL CITY
3
ENCINO TARZANA
SHERMAN OAKS STUDIO CITY
1
BEL AIR BEVERLY CREST
HOLLYWOOD
NORTHEAST LOS ANGELES
BRENTWOOD PACIFIC PALISADES
CENTRAL
BEVERLY HILLS
SILVER LAKE ECHO PARK
WESTWOOD
WILSHIRE
WESTERN LOS ANGELES
WEST LOS ANGELES CENTURY CITY RANCHO PARK
WESTADAMS LEIMERT BALDWIN
WESTLAKE
CENTRAL CITY
BOYLE HEIGHTS
SANTA MONICA
PALMS MAR VISTA DEL REY
4
NORTH & EAST CENTRAL CITY
VENICE
CULVER CITY
SOUTH CENTRAL LOS ANGELES
WESTCHESTER PLAYA DEL REY
SOUTHEAST LOS ANGELES
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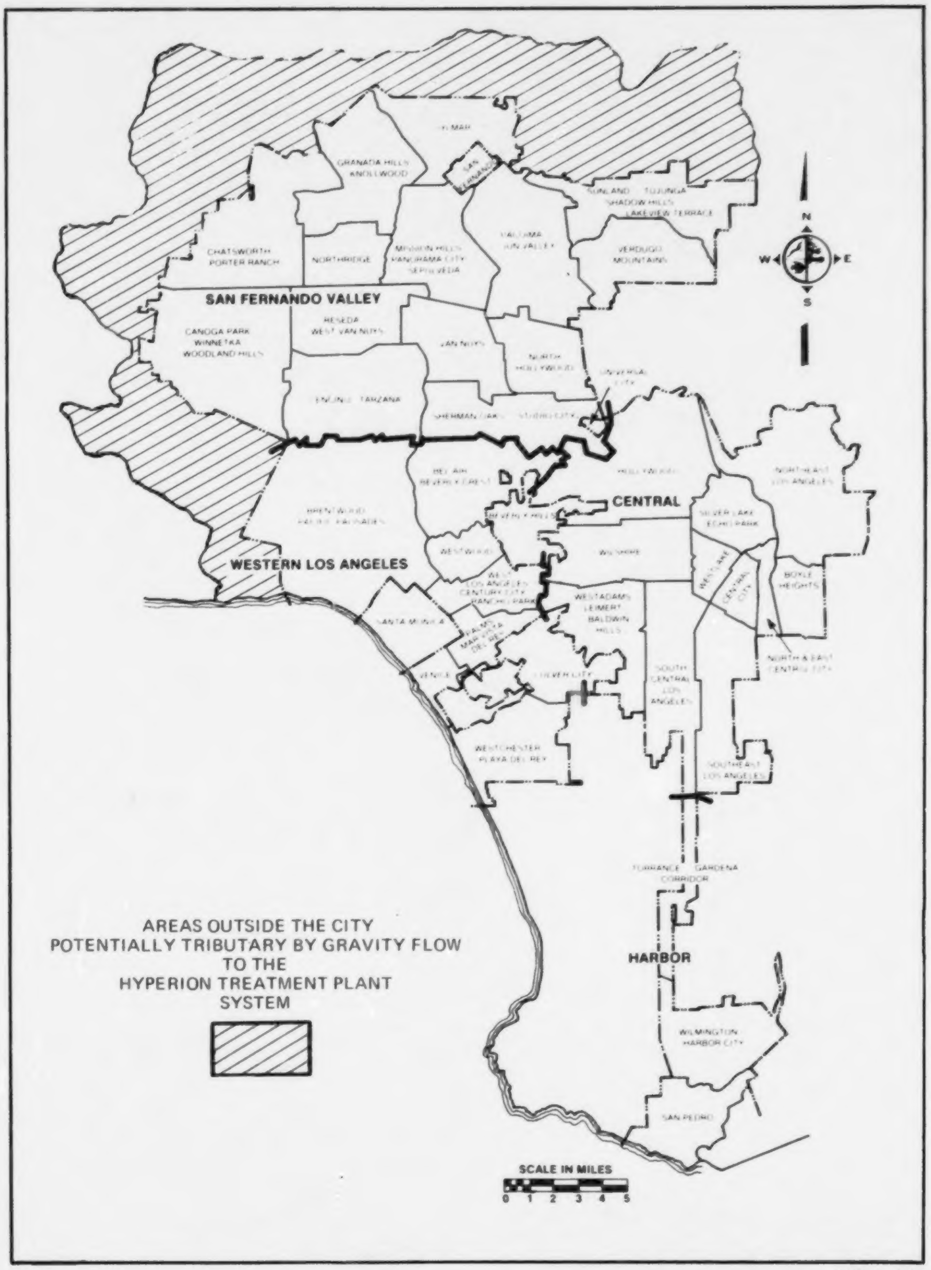
TORRANCE GARDENA CORRIDOR
HARBOR
INTERCEPTOR SEWER SYSTEM TRIBUTARY AREAS IN HTP SERVICE AREA
WILMINGTON HARBOR CITY
SAN PEDRO
AREA 1 COASTAL INTERCEPTOR SEWER SYSTEM
AREA 2 NOS-LCSFVRS INTERCEPTOR SEWER SYSTEM
AREA 3 NCOS-NOS INTERCEPTOR SEWER SYSTEM
AREA 4 COS INTERCEPTOR SEWER SYSTEM
SCALE IN MILES
0 1 2 3 4 5

198P–327

Figure VI-6. Interceptor sewer system tributary areas in the HTP Service Area (Bureau of Engineering, 1976).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SHERMAN OAKS STUDIO CITY
BEL AIR
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PACIFIC PALISADES
BEVERLY HILLS
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WILSHIRE
WESTERN LOS ANGELES
WEST
LOS ANGELES
CENTURY CITY
RANCHO PARK
WESTLAKE
CENTRAL
CITY
BOYLE
HEIGHTS
WESTADAMS
LEIMERT
BALDWIN
HILLS
SANTA MONICA
PALMS
MAR VISTA
DEL REY
NORTH & EAST
CENTRAL CITY
VENICE
CULVER CITY
SOUTH
CENTRAL
LOS
ANGELES
WESTCHESTER
PLAYA DEL REY
SOUTHEAST
LOS ANGELES
TORRANCE GARDENA
CORRIDOR
HARBOR
WILMINGTON
HARBOR CITY
SAN PEDRO
AREAS OUTSIDE THE CITY
POTENTIALLY TRIBUTARY BY GRAVITY FLOW
TO THE
HYPERION TREATMENT PLANT
SYSTEM
SCALE IN MILES
0 1 2 3 4 5

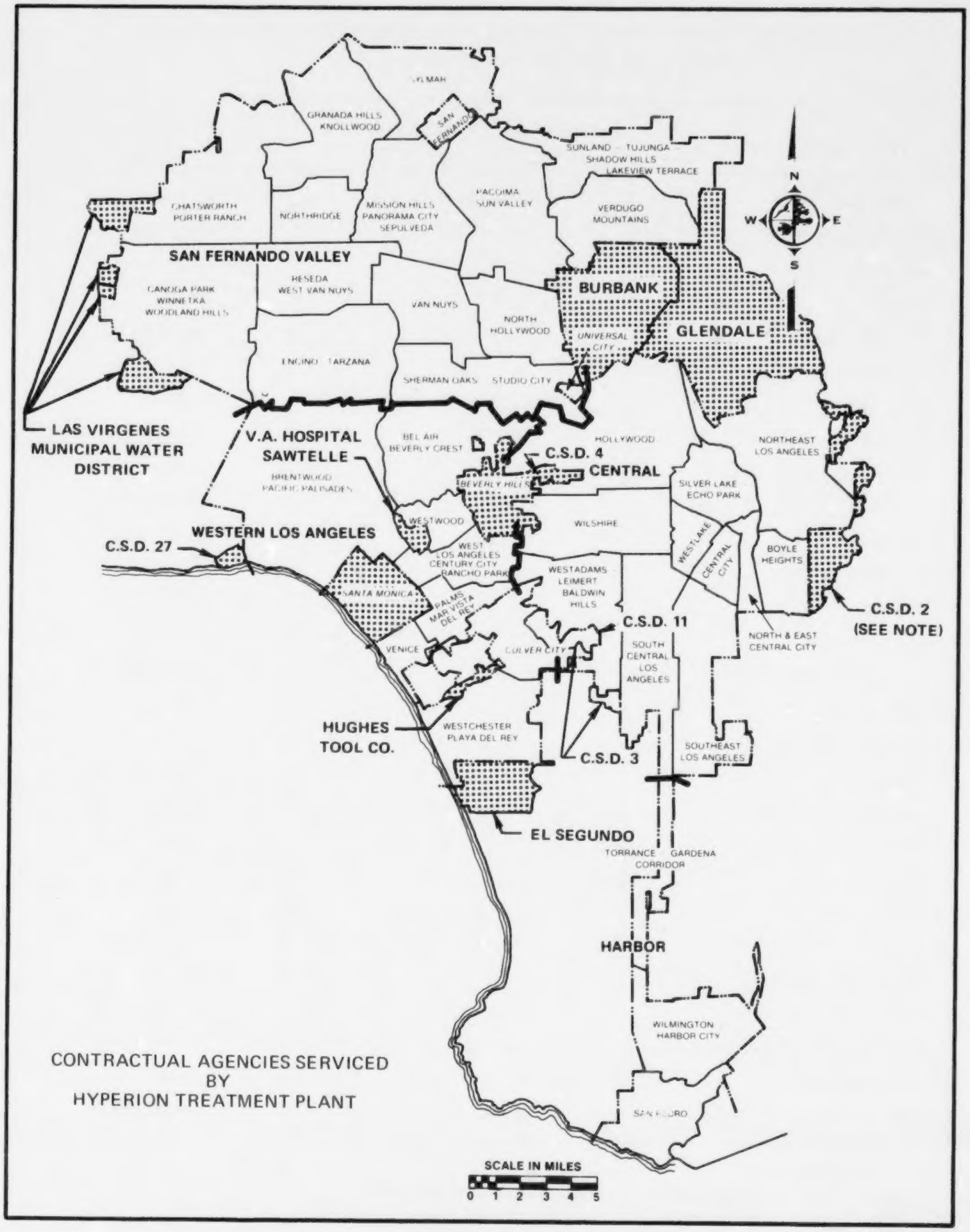
198P—328

Figure VI-7. Areas outside the City potentially tributary by gravity flow to the Hyperion Treatment Plant System.

Table VI-1. Contractual agencies discharging wastewater to the Hyperion Treatment Plant.

NAME OF AGENCY	CONTRACTUAL FLOW RIGHTS IN HTP,AVG.FLOW (MGD)	1975-1975 FLOW[1] (MGD)
Aneta St. MD	Floating Rate	Negligible
Barrington P.O.	Flat Rate	Negligible
Beverly Hills	7.2610	6.10
Burbank	10.00	6.75
Ca. Nat'l Guard	Flat Rate	Negligible
Co. San. Dist. No. 2[2]	-[3]	1.32
Co. San. Dist. No. 4	6.60	4.45
Co. San. Dist. No. 5	1.661[2]	0.78
Co. San. Dist. No. 9	0.35[4]	0.31
Co. San. Dist. No. 11	-[3]	Negligible
Co. San. Dist. No. 16	0.4903	0.43
Co. San. Dist. No. 27	0.30	0.18
Culver City	6.706	4.52
El Segundo	2.750	1.92
Fed. Off. Bldg. WLA	0.13	Negligible
Glendale	19.15	16.05
Hughes Tool Co.	Rental Fee	0.29
Inglewood	Flat Rate	Negligible
Las Virgenes MWD	Rental Fee	Negligible
Marina Del Rey	3.00	3.20
San Fernando	1.1375	1.61
Santa Monica	11.0000	11.13
Universal City	0.1616	0.11
U.S. Air Reserve	Flat Rate	Negligible
U.S. Army Reserve	Flat Rate	Negligible
U.S. Navy, Terminal Island	1.600[4]	0.44
V.A. Sawtelle	1.36[5]	0.34
WLA College	0.70	Negligible

[1] Flows less than 0.1 mgd are considered negligible
[2] Effective January 1976, no longer tributary to Hyperion System
[3] Rights in sewers only
[4] Contractual flow rights in Terminal Island Treatment Plant
[5] Approximation - no specified rights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SAN FERNANDO
SUNLAND - TUJUNGA SHADOW HILLS LAKEVIEW TERRACE
CHATSWORTH PORTER RANCH
NORTHRIDGE
MISSION HILLS PANORAMA CITY SEPULVEDA
PACOIMA SUN VALLEY
VERDUGO MOUNTAINS
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SAN FERNANDO VALLEY
CANOGA PARK WINNETKA WOODLAND HILLS
RESEDA WEST VAN NUYS
VAN NUYS
NORTH HOLLYWOOD
BURBANK
GLENDALE
UNIVERSAL CITY
ENCINO - TARZANA
SHERMAN OAKS
STUDIO CITY
LAS VIRGENES MUNICIPAL WATER DISTRICT
V.A. HOSPITAL SAWTELLE
BEL AIR BEVERLY CREST
HOLLYWOOD
C.S.D. 4
CENTRAL
NORTHEAST LOS ANGELES
BRENTWOOD PACIFIC PALISADES
BEVERLY HILLS
SILVER LAKE ECHO PARK
WESTWOOD
WILSHIRE
WESTERN LOS ANGELES
C.S.D. 27
WEST LOS ANGELES CENTURY CITY RANCHO PARK
WESTLAKE
CENTRAL CITY
BOYLE HEIGHTS
SANTA MONICA
WESTADAMS LEIMERT BALDWIN HILLS
PALMS MAR VISTA DEL REY
C.S.D. 2 (SEE NOTE)
C.S.D. 11
NORTH & EAST CENTRAL CITY
VENICE
CULVER CITY
SOUTH CENTRAL LOS ANGELES
HUGHES TOOL CO.
WESTCHESTER PLAYA DEL REY
C.S.D. 3
SOUTHEAST LOS ANGELES
EL SEGUNDO
TORRANCE GARDENA CORRIDOR
HARBOR
WILMINGTON HARBOR CITY
CONTRACTUAL AGENCIES SERVICED BY HYPERION TREATMENT PLANT
SAN PEDRO
SCALE IN MILES
0 1 2 3 4 5

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Figure VI-8. Contractual agencies serviced by Hyperion Treatment Plant.

Negotiations to provide sewage disposal capacity to cities and agencies generally follow the provision of Ordinance No. 114,579 under which the Board of Public Works is authorized to negotiate agreements for this purpose. In these agreements, the other party must pay its proportionate share of capital costs and annual costs, based on the relation of its contractual capacity to the design capacity of the various parts of the system which it uses. There are also provisions for payment of costs of flow measurement and contract administration, as well as payment of a share of any future capital costs of the facilities used.

In some cases, such as the recent Barrington Post Office agreement, where very small quantities are involved, fixed annual payments are substituted to avoid administrative costs which are out of proportion to the service rendered. However, the charges are calculated to cover a reasonable estimate of all applicable costs.

In other cases, where capacity is available only on a temporary basis, as in one of the sewers used in the most recent Marina del Rey agreement, an annual rental is charged until Los Angeles can build additional capacity with joint participation in the cost by the other party.

As an effect of the recently adopted Sewerage Facilities Charge Ordinance, it is now desirable to make certain that the methods of cost determination for other agencies do not happen to offer more favorable conditions to persons outside the City than can be provided to persons in adjacent territory inside the City. If such a discrepancy were to be noted, the charges would be adjusted to maintain equity.

(5) COLLECTION SYSTEM. The Hyperion collection system consists of a series of local collector and interceptor sewers terminating at HTP. Table VI-2 shows the statistical data of mainline sewers that are part of this collection system.

There are four main interceptor sewers tributary to the HTP. Terminating at the HTP, these sewers are designated as the North Outfall Sewer (NOS), the North Central Outfall Sewer (NCOS), the Central Outfall Sewer (COS), and the Coastal Interceptor Sewer (CIS). Over the years, as these major sewers were extended upstream throughout the City, their designations (NOS, NCOS, etc.) were not retained generally because of system flow diversions. Therefore, for the purpose of clarification, these interceptors will be referred to in terms of their system names as designated in Table VI-3 .

The configuration of these four Interceptor Sewer Systems is shown on Figure VI-9. The tributary areas of these systems are also delineated in Figure VI-10.

(a) Major Deficiencies. There are three major deficiencies with the NOS-LCSFVRS interceptor sewer system. The first involves a need for hydraulic relief of portions of the NOS and VORS in the San Fernando Valley downstream of the Sepulveda Flood Control Basin. The rapid growth in the San Fernando Valley in recent years has generated flows

Table VI-2. Characteristic statistical data for mainline sewer system.

ITEM	% OF SYSTEM MILEAGE	CHARACTERISTIC INSTALLATION PERIOD	CHARACTERISTIC CONDUIT MATERIALS	ESTIMATED CHARACTERISTIC CONDUIT SIZES
PIPE SIZES				
6"	1.2	Pre-1930	Cement VCP,CIP	
8"	80.7	All Periods	"	
10"	4.1	All Periods	"	
12"	2.9	All Periods	"	
15", 16"	2.9	All Periods	"	
18"	2.9	All Periods	"	
21",24",27"	3.1	Post-1930	"	
30",33",36"	0.7	Post-1930	VCP, CIP	
39",42",45"	0.4	Post-1930	VCP, RCP	
48",51",54"	0.5	Post-1930	RCP	
57",60",63"	0.2	Post-1930	RCP	
72",78"	0.3	Post-1930	RCP	
90",96"	0.2	Post-1950	RCP	
PIPE MATERIALS				
Clay (VCP)	83.7	To Present		6" - 42"
Cement	12.5	Pre-1930		8" - 18"
Reinf. Conc. (RCP)	1.5	1935-Present		42" - 96"
Monolithic Conc.	0.7	Pre-1930		42" - 60"
Brick Conc.	0.5	Pre-1930		24" - 42"
Cast Iron (CIP)	0.4	To Present		6" - 30"
Brick	0.3	Pre-1930		24" - 30"

Table VI-3. Nomenclature of interceptor sewer system.

INTERCEPTOR SEWER SYSTEM	NOMENCLATURE	SEWER SYSTEM TERMINATING AT HTP
North Outfall Sewer - La Cienega - San Fernando Valley Relief Sewer	NOS - LCSFVRS	NOS
North Central Outfall Sewer - North Outfall Sewer	NCOS - NOS	NCOS
Central Outfall Sewer	COS	COS
Coastal Interceptor Sewer	CIS	CIS

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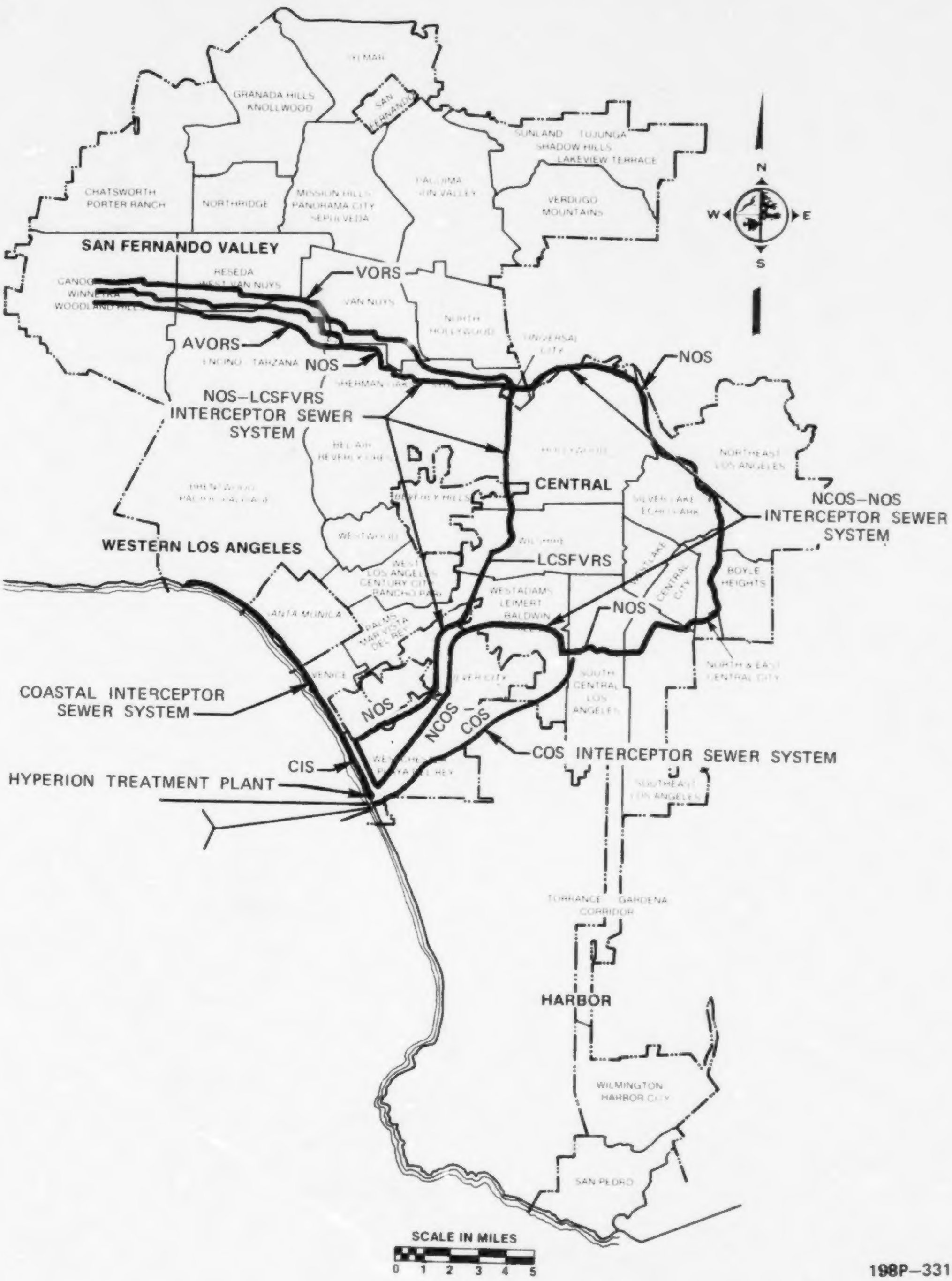
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LAKEVIEW TERRACE
CHATSWORTH
PORTER RANCH
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MISSION HILLS
PANORAMA CITY
SEPULVEDA
PACOIMA
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CANOGA
WINNETKA
WOODLAND HILLS
RESEDA
WEST VAN NUYS
VORS
VAN NUYS
NORTH
HOLLYWOOD
UNIVERSAL
CITY
AVORS
ENCINO TARZANA
NOS
SHERMAN OAKS
NOS
NOS–LCSFVRS
INTERCEPTOR SEWER
SYSTEM
BEL AIR
BEVERLY CREST
HOLLYWOOD
NORTHEAST
LOS ANGELES
BRENTWOOD
PACIFIC PALISADES
BEVERLY HILLS
CENTRAL
SILVER LAKE
ECHO PARK
NCOS–NOS
INTERCEPTOR SEWER
SYSTEM
WESTWOOD
WILSHIRE
WESTERN LOS ANGELES
LCSFVRS
WESTLAKE
CENTRAL
CITY
BOYLE
HEIGHTS
WEST
LOS ANGELES
CENTURY CITY
RANCHO PARK
WESTADAMS
LEIMERT
BALDWIN
SANTA MONICA
PALMS
MAR VISTA
DEL REY
NOS
VENICE
CULVER CITY
NORTH & EAST
CENTRAL CITY
SOUTH
CENTRAL
LOS
ANGELES
COASTAL INTERCEPTOR
SEWER SYSTEM
NOS
NCOS
COS
COS INTERCEPTOR SEWER SYSTEM
CIS
WESTCHESTER
PLAYA DEL REY
HYPERION TREATMENT PLANT
SOUTHEAST
LOS ANGELES
TORRANCE GARDENA
CORRIDOR
HARBOR
WILMINGTON
HARBOR CITY
SAN PEDRO
SCALE IN MILES
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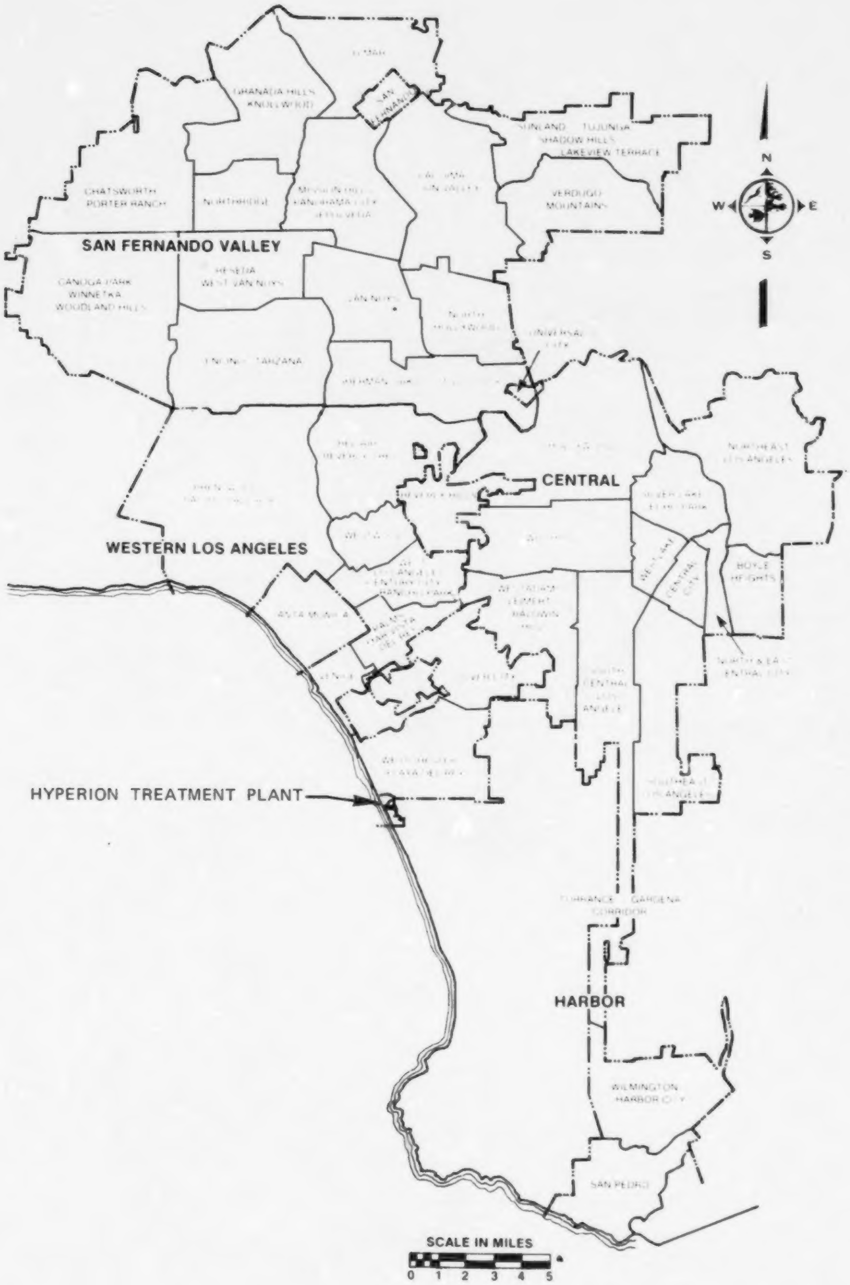
Figure VI-9. Major interceptor sewer systems tributary to the Hyperion Treatment Plant.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NORTHRIDGE
MISSION HILLS
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HYPERION TREATMENT PLANT
TORRANCE GARDENA
CORRIDOR
HARBOR
WILMINGTON
HARBOR CITY
SAN PEDRO
SCALE IN MILES
0 1 2 3 4 5

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Figure VI-10. Tributary areas of the coastal, NOS-LCSFVRS, NCOS-NOS, and COS Interceptor Sewer Systems.

which exceed the design capacity of the NOS and VORS at various locations. There are alternatives for providing relief, such as construction of relief sewers and corresponding increase in capacity of the Hyperion Treatment Plant (for secondary treatment) of the construction of an inland treatment plant in the Sepulveda Basin.

The second problem exists at the overflow structure at Jackson Avenue in Culver City. During very intense storms, excess flow in the North Outfall Sewer overflows into Ballona Creek, an improved watercourse tributary to the Pacific Ocean. Discharge is provided for by means of a structure designed to prevent buildup of internal pressures in the downstream reach of the NOS because the sewer is an unreinforced monolithic concrete conduit not designed for pressure flow. Experimental field work is being carried out to determine whether it is feasible to control sources of infiltration/inflow to the sewer system to eliminate this excess flow. When field work is completed, an analysis will be made to determine the most cost-effective procedure for processing or controlling this overflow.

The third problem is in the same North Outfall Sewer between the intersection of Duquesne Street and Jefferson Boulevard and the Hyperion Treatment Plant. This reach was constructed in the middle 1920s without steel reinforcing and has since deteriorated. The clay tiles which were installed to protect the concrete have fallen off in some locations, leaving bare concrete exposed to corrosion by sewer gas. As a precautionary measure, a reinforced concrete blanket has been constructed over some reaches of the sewer. Also, ventilation stations have been constructed on the NOS to aid in the slowing of deterioration. However, at some time in the future, it may be necessary to construct a replacement for this sewer. The location of these three problem areas can be seen on Figure VI-11.

Only one major deficiency exists on the NCOS-NOS interceptor sewer system. This problem occurs on the NOS where it crosses under the Los Angeles River just northwest of the Pasadena Freeway. At this location, the NOS has been exhibiting excessive leakage. To remedy this problem, approximately 1,050 feet of 48-inch plastic-lined RCP will be constructed under the Los Angeles River to replace the NOS.

(b) Infiltration and Inflow. Infiltration and inflow both occur in the City's sewer system. The terminology "inflow" applies to storm flow directly entering the system through leaky manhole covers or illegal drainage connections; "infiltration" applies to groundwater flow entering through cracked pipes, manholes, and deteriorated pipe joints. Most such action undoubtedly occurs in older sections of the system where presently required design and testing procedures were not utilized. However, no particular portion of the system has been identified as a problem area except those sections subject to sea water intrusion.

To lessen inflow, since 1948, the City has utilized a sewer manhole inner cover calked to prevent leakage wherever the designer determines that storm flow of significant depth could occur above the cover. Illegal connections are ordered removed whenever found.

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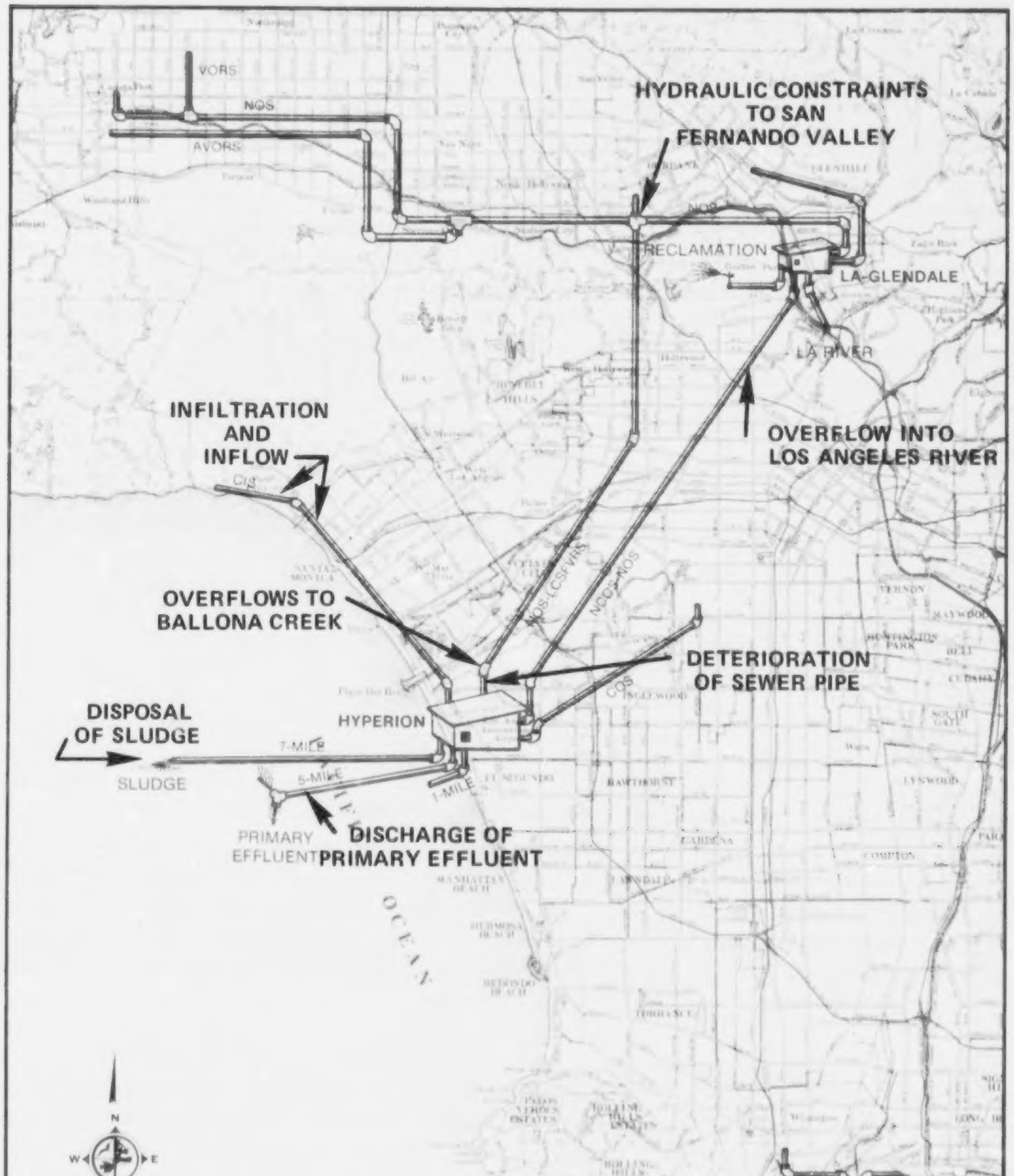
VORS
NOS
AVORS
HYDRAULIC CONSTRAINTS TO SAN FERNANDO VALLEY
NOS
RECLAMATION
LA-GLENDALE
LA RIVER
OVERFLOW INTO LOS ANGELES RIVER
INFILTRATION AND INFLOW
CIS
NOS-LCSFVIRS
NCOS-NOS
OVERFLOWS TO BALLONA CREEK
DETERIORATION OF SEWER PIPE
COS
DISPOSAL OF SLUDGE
HYPERION
7-MILE
5-MILE
1-MILE
SLUDGE
PRIMARY EFFLUENT
DISCHARGE OF PRIMARY EFFLUENT
OCEAN
N
W
E
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TERMINAL ISLAND
LANDFILL
DISCHARGE OF PRIMARY EFFLUENT
198P-11

Figure VI-11. Problem areas of existing system.

As for infiltration, construction specifications have provided for leakage tests since the early 1930s, but at first, only where groundwater was encountered during construction. Today these specifications require sealing of standard pipe joints by compression bands and mortar or the use of polyvinyl chloride or polyurethane joints, as determined by expected internal and external fluid pressures. Also required are infiltration, exfiltration or air pressure tests prior to construction acceptance by the Engineer. Stringent criteria for allowable leakage are specified. Requirements now in effect for house connection sewers require caulking of all joints and the use of hot-poured joint compound or flexible compression joints.

(c) Maintenance. The City has no serious maintenance problem with its sewer system except those previously mentioned. The majority of the pipe material is clay, a long-lasting material with an indefinite life not subject to attack by hydrogen sulfide. Since the mid-1940s, for its larger sewers, the City has utilized reinforced sheeting to protect the concrete from corrosion. There have been recurrent problems with the early concrete pipe, some of which has been replaced and additional future replacement of such pipe may be necessary.

Routine maintenance activities include: clearance of stoppages, general cleaning and flushing, minor repairs, manhole adjusting and sealing, and odor and corrosion control.

(6) PUMPING PLANTS. Within the Hyperion Treatment Plant Service Area, the City operates and maintains 29 wastewater pumping plants. These pumping plants vary in size from the pneumatic ejector types with capacities of about 30 to 100 gallons per minute (gpm) to the Venice Pumping Plant with a capacity of 35,000 gpm.

The only major deficiency on the pumping systems tributary to HTP is at the Venice Pumping Plant which is presently operated near design capacity. If it is determined that the existing pumping plant needs to be enlarged, then a new pumping plant and site would be required due to limitations at the present site. Also, if the plant is reconstructed, Culver City and Marina del Rey will ask for additional capacity rights. The present dominance of HTP as the major element in the overall City Sewer System, and the need for additional secondary treatment capacity to meet regulatory requirements, even after completion of presently committed projects is evident.

b. Terminal Island Treatment Plant.

(1) LOCATION. The Terminal Island Treatment Plant (TITP) is located on Terminal Island in the Los Angeles Harbor area at the northwest corner of Terminal Way and Ferry Street. The site is rectangular in layout with an area of approximately 19 acres. Figure VI-1 shows the plant location, collection system configuration, and service area for TITP. Figure VI-12 is an aerial view of the plant.

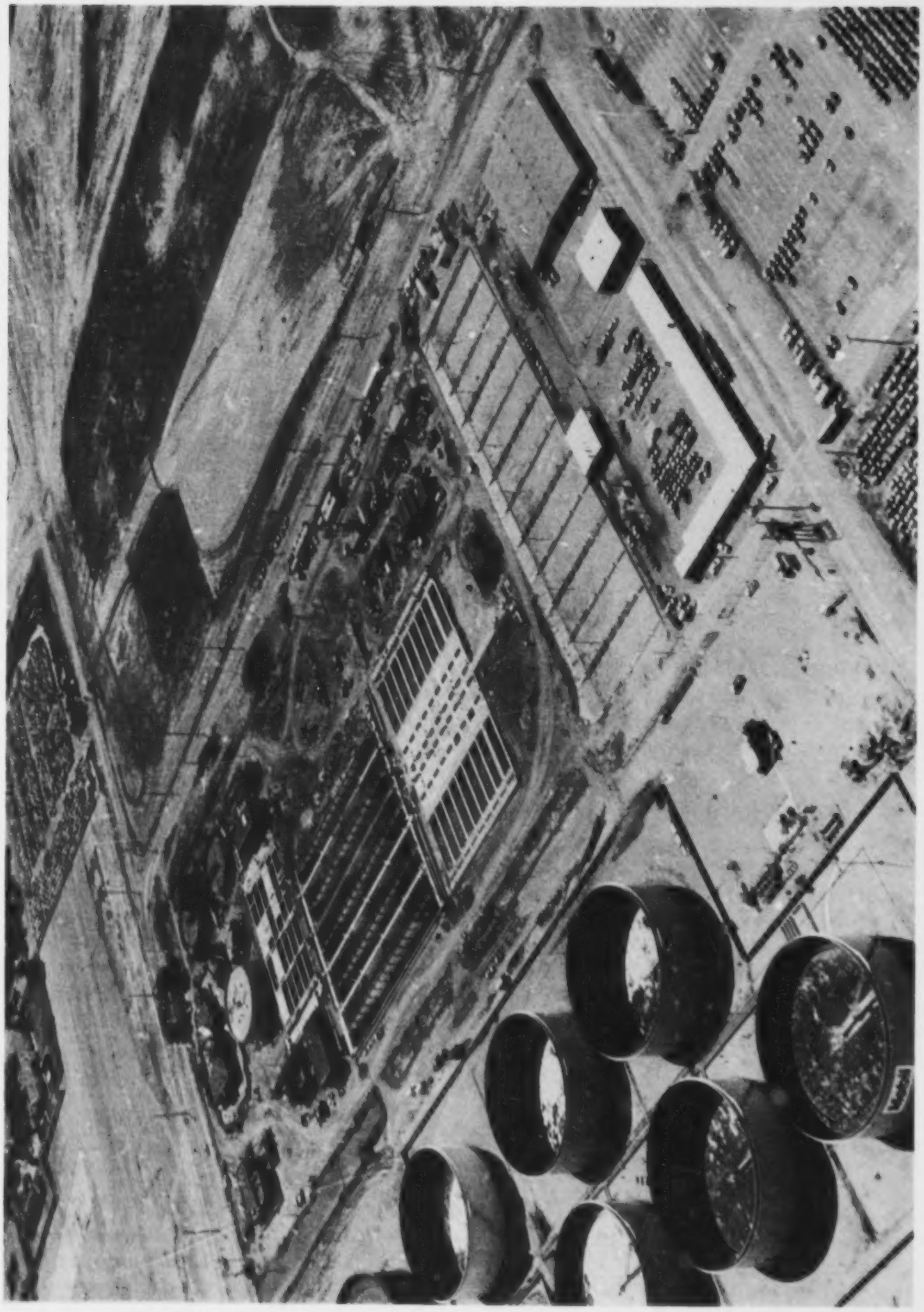

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Figure VI-12. Aerial view of the Terminal Island Treatment Plant.

(2) OCEAN OUTFALL. A 39-inch diameter outfall, extending approximately 450 feet offshore, is presently used for discharge of plant effluent into the outer harbor.

(3) SERVICE AREA. The service area for TITP comprises the Harbor area of the City of Los Angeles. This area includes the communities of Wilmington and San Pedro, Terminal Island, and a portion of Harbor City. This area is located approximately 20 miles south of downtown Los Angeles. The area, being geographically isolated from the rest of the City, requires a separate collection, treatment and disposal system. The system consists of pumping plants, force mains, collector sewers, interceptor sewers, the TITP and an outfall sewer.

The land use patterns in the service area are not expected to change significantly in the next several decades.

(4) CONTRACTUAL AGENCIES. The wastewater collection systems serving the area come under the jurisdiction of four separate entities: (1) the City of Los Angeles; (2) the Los Angeles County Sanitation Districts; (3) the Los Angeles Harbor Department, and (4) the United States Department of the Navy. Most of the area is served by the wastewater system of the City of Los Angeles.

The existing collection system serves only domestic and small industrial users and is inadequate for the large industrial wastewater flows which are currently discharged to the Harbor. The City is presently constructing modifications to the collection system to permit the collection of all wastewater flows generated within the Harbor area. This new system is known as the Harbor Sewerage Collection System.

The Los Angeles Harbor Department operates four wastewater pumping stations. Two of these pumping facilities serve as lift stations to deliver wastes from docking facilities located on the west side of the main channel to the collection system of the City of Los Angeles. The other two pumping stations, located near Fish Harbor, are used to transfer wastes from the fish canneries into a 42-inch outfall discharging to the Outer Harbor that is also operated by the Harbor Department.

The Los Angeles County Sanitation Districts (LACSD) have a wastewater pumping plant located in the Harbor City area. A section of the City of Los Angeles is served by this facility, which is used to transfer wastewater through a 24-inch force main to the Joint Disposal Plant of the LACSD. Three small areas of Los Angeles County are located within the Harbor area boundaries, and wastes from these areas drain into the collection system of the City.

Wastewater from the United States Naval Complex is presently transported to the City's Terminal Island Treatment facility through a series of force mains and pumping stations. The Navy is currently implementing a number of construction programs to provide adequate capacity for collecting and transporting future wastewater flows to the Terminal Island Plant.

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The Navy presently operates ten pumping stations at its Long Beach Complex (which includes the Naval Station, Supply Center and shipyard activities), one station at Reeves Field, and one station at the Naval Supply Depot located on the west channel of the Harbor. Pumping stations on piers of the Long Beach Complex wharf area are used to transfer dock and ship wastes into a pressure pipeline to the TITP. The responsibility for operating the pumping facility at Reeves Field will revert to the Harbor Department in 1979. A new force main and pumping station on the Navy Mole is planned to serve the facilities that will be transferred from Reeves Field to the Mole. The pumping station at the Naval Supply Depot delivers wastes from that facility to the City Sewer System.

A portion of the City of Los Angeles within the Harbor area located east of the Consolidated Slip, is tributary to the City of Long Beach sewer system. Wastewater from this area is ultimately transferred to the LACSD Joint Treatment Plant because the Long Beach system is tributary to that facility. A contract between the Cities of Los Angeles and Long Beach, which has been in existence since 1926, permits the City of Los Angeles to discharge a maximum of 5.35 cfs to the Long Beach system.

(5) COLLECTION SYSTEM. The influent system to TITP consists of the following force mains:

- 30" Fries Avenue Force Main (FISS)
- 20" Terminal Way Force Main (TISS)
- 30" San Pedro Force Main (under construction) (SPISS)
- 6" to 20" - 4 U.S. Navy Force Mains

For purpose of this writing, the interceptor sewers tributary to these force mains will be defined as the major Interceptor Sewer Systems tributary to TITP.

(a) Major Deficiencies. There are no known major deficiencies on the Interceptor Sewer Systems tributary to TITP.

(b) Infiltration and Inflow. Groundwater infiltration takes place in many of those sewers nearest to the Harbor shores, inasmuch as most of the sewer system is quite old and reflects the type of sewer joint construction that prevailed many years ago. However, groundwater infiltration is not a major problem with the Terminal Island System. Inflow is also not a major problem with this system.

(c) Maintenance. See section under Hyperion Treatment Plant for discussion of collection system maintenance.

(6) PUMPING PLANTS. The City has 22 pumping plants within the general area of the TITP. Twenty of these plants are tributary to the TITP, while two pumping plants are tributary to facilities of the Los Angeles County Sanitation Districts.

c. Los Angeles-Glendale Water Reclamation Plant

(1) LOCATION. The Los Angeles-Glendale Water Reclamation Plant (LAGWRP) is located at the southeast junction of the Los Angeles River Flood Control Channel (L.A. River) and Colorado Boulevard between Griffith Park and the City of Glendale. Both the plant location and service area are shown on Figure VI-1. Figure VI-13 is an aerial view of the plant.

(2) OUTFALL. The tertiary treated effluent from LAGWRP will either be reclaimed by the Cities of Los Angeles and Glendale and/or discharged to the L.A. River. The sludge will be transported to the Hyperion Treatment Plant via the NCOS-NOS Interceptor Sewer System.

(3) SERVICE AREA. The following areas are within the service area of LAGWRP:

- Portions of the City of Glendale that are tributary to the NOS.
- Portions of the City of Burbank which contribute flow to the NOS. The other areas of Burbank are tributary to Burbank Water Reclamation Plant from which sludge is discharged to the LAGWRP via the NOS.
- Portions of the City of Los Angeles which are directly tributary to the NOS from a point immediately downstream of the diversion to the La Cienega and San Fernando Valley Relief Sewer at Valley Spring Lane and Forman Avenue to a point on the NOS where the flow is diverted into the LAGWRP.
- Portions of the City of Los Angeles which are indirectly tributary to the NOS via the collection systems of the Cities of Glendale and Burbank.
- Unincorporated areas of Los Angeles County, including portions of La Crescenta and Montrose, which may eventually be connected to the City of Glendale sewer system.

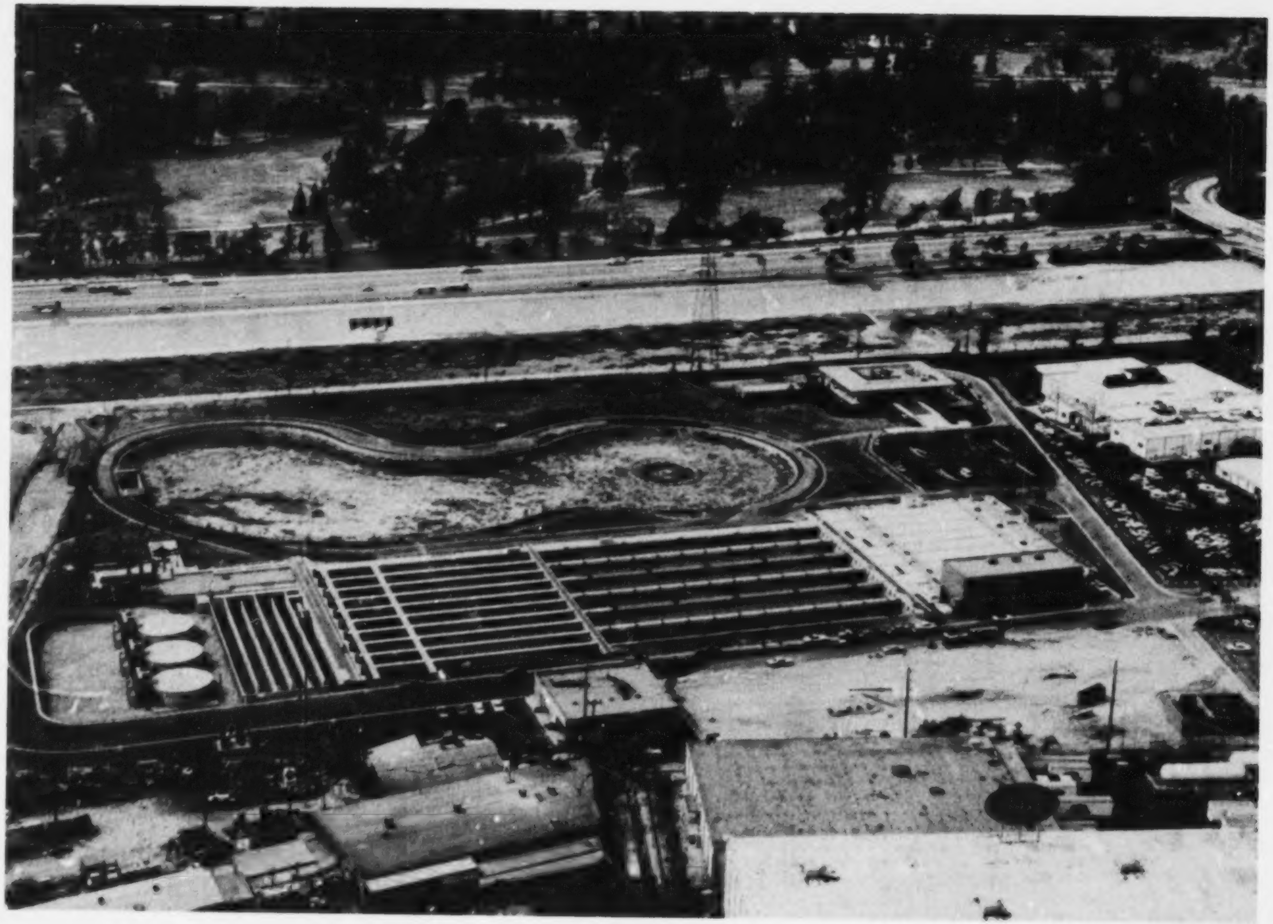

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Figure VI-13. Aerial view of the Los Angeles-Glendale Water Reclamation Plant.

(4) CONTRACTUAL AGENCIES. The City of Burbank has contractual capacity rights of 7.4 mgd (11.5 cfs) average flow capacity in the NOS, and its recent contributions have been within these capacity rights. No limitation is placed upon their peak flow contribution. They also have rights to 10.0 mgd (15.5 cfs) capacity at Hyperion Treatment Plant.

The City of Glendale contracts with the City of Los Angeles for wastewater treatment service, having a contractual peak capacity in the NOS of 17.1 mgd (26.5 cfs) and in the La Cienega and San Fernando Valley Relief Sewer (LCSFVRS) of 6.8 mgd (10.5 cfs), for a total of 23.9 mgd (37.0 cfs). Glendale's peak flow has been about 56.4 mgd (37 cfs) with an average flow of about 16 mgd and has capacity rights to 19.2 mgd (29.7 cfs) at Hyperion Treatment Plant. In addition to this, the City of Glendale will have capacity rights to 10 mgd (15.5 cfs) at LAGWRP.

There are certain areas of the City of Los Angeles that are tributary by gravity to Burbank and to Glendale. This resulted in the City obtaining contractual rights in the collection system of Burbank and Glendale for 1.3 mgd (2.0 cfs) and 1.5 mgd (2.26 cfs), respectively.

(5) COLLECTION SYSTEM.

(a) Interceptor System. The only interceptor sewer directly tributary to LAGWRP is the NOS, which has a peak capacity of 77 cfs (49.7 mgd) immediately upstream of the plant. The most significant collection systems connecting to the NOS upstream of the plant are those of the city of Burbank and the City of Glendale.

Within the City of Burbank, there are areas which are directly tributary to the NOS and areas which are indirectly tributary to the NOS via the Burbank Water Reclamation Plant, which returns undigested sludge to Burbank sewers and subsequently to the NOS.

The City of Glendale has no sewage treatment or water reclamation facilities at present. Sewage generated in Glendale discharges to the NOS through seven interceptor sewers.

In addition to Burbank and Glendale sewerage connections to the NOS downstream of the LCSFVRS, there are some direct and indirect gravity contributions from Los Angeles areas.

(b) Major Deficiencies. There are no known major deficiencies on the collection system tributary to LAGWRP.

(c) Infiltration and Inflow. Gauging data have shown that Burbank's wet-weather peaks are not much greater than the dry weather peaks, indicating a fairly weather-proof collection system. Groundwater infiltration problems appear minimal. The lowering of the water table in the San Fernando Valley has generally reduced whatever sewer infiltration problems existed in former years.

(6) PUMPING PLANTS. Lake Street Pumping Plant, which is owned and operated by the City of Glendale, is the only pumping plant on the collection system tributary to LAGWRP. This plant is located adjacent to the Los Angeles River and directly under the Ventura Freeway Bridge and pumps wastewater generated in the southwest corner of Glendale into the NOS via an 18" sewer.

Among the environmental concerns associated with construction of this plant the most immediately apparent is the discharge of tertiary treated effluent into the Los Angeles River. Some of this effluent will percolate to presently used groundwaters, since the river bottom is unlined for a short distance below the plant. The remainder will result in an increased flow in the river, with the attendant possibilities of health hazards, creation of unsightly conditions through algal growth, and increased potential for mosquito breeding (Chapter VII).

d. Burbank Water Reclamation Plant. The Burbank Water Reclamation Plant (BWRP), owned and operated by the City of Burbank, was placed in operation in the summer of 1966. The plant was constructed for the purpose of providing sewage disposal capacity for the city of Burbank, thus limiting Burbank's discharge to the NOS and precluding the necessity for acquiring additional contractual capacity in the NOS and the Hyperion System. The plant was originally designed for a capacity of 6 mgd and is presently being upgraded to 9 mgd to handle additional needs and to not exceed the present contractual flow of 7.4 mgd in the NOS. The 9 mgd plant capacity should be adequate to serve Burbank's needs through the year 2000.

(1) LOCATION. The BWRP is located within the City of Burbank (see Figure VI-1) in an area bounded by Burbank Boulevard on the north, Victory Boulevard on the west, Southern Pacific Railroad (Chatsworth Branch) on the south, and the Burbank Western Channel on the east. The site is approximately three and one-half acres in size and is surrounded by land devoted to light industrial use, flood control, and railroad rights-of-way. The plant's expansion is located to the west and south of the existing facilities on the same site.

(2) OUTFALL. The BWRP presently treats an average flow of 6 mgd. Approximately 1.5 mgd of the plant effluent produced is piped to the Burbank Steam Plant for use as cooling tower makeup water. The remaining effluent is discharged to the Burbank Western Flood Control Channel, a tributary channel to the Los Angeles River. When the 3 mgd expansion of the plant is completed in 1976, additional reclaimed water use will include 0.2 mgd for industrial users, 0.3 mgd for golf course irrigation, and up to 6.0 mgd for hillside irrigation and/or groundwater injection. All sludge produced by the BWRP is discharged to a sewer in Beachwood Drive for conveyance to and ultimate disposal at the Hyperion Treatment Plant.

(3) SERVICE AREA. The BWRP Service Area is delineated in Figure VI-1. A small portion of the City of Los Angeles sewage flow is tributary to Burbank's collection system. Most of this flow is tributary to the BWRP.

(4) CONTRACTUAL AGENCIES. The City of Burbank has average flow contractual rights of 7.4 mgd (11.5 cfs) in the City of Los Angeles' NOS system. Burbank also has rights to 10.0 mgd (15.5 cfs) capacity at the Hyperion Treatment Plant, and it is believed that their contractual rights will not change. Under the existing agreement, Los Angeles has 1.3 mgd (2.0 cfs) capacity rights in Burbank's collection system to transport the portion of the City of Los Angeles' flow which is tributary by gravity to the City of Burbank.

(5) COLLECTION SYSTEM. The BWRP has three major interceptor sewers tributary to the plant. Two of these sewers are operational and supply the wastewater for the existing 6 mgd facility. The third sewer is under construction and will supply the additional flow for the 3 mgd increase in treatment capacity presently under construction.

(6) PUMPING PLANTS. The City of Burbank has one pumping plant on its collection system which will become operational when the additional 3 mgd capacity becomes available at the BWRP. The pumping plant is designed to handle 3 mgd.

e. Valley Settling Basin. The Valley Settling Basin (VSB) is located in Griffith Park easterly of the intersection of Forest Lawn Drive and the Golden State Freeway as shown in Figure VI-1. The VSB was placed in operation in 1954 as a retention facility to relieve the North Outfall Sewer from peak sewage flows which were in excess of its hydraulic capacity.

This hydraulic relief operation was continued until the La Cienega and San Fernando Valley Relief Sewer and the North Central Outfall Sewer were placed in operation in 1956 and 1958, respectively. It has since been put out of service as a retention facility and is presently used as an experimental water reclamation plant and training facility with a design capacity of one mgd.

f. Los Angeles Zoo Treatment Plant. The Los Angeles Zoo Treatment Plant (LAZTP) is located on the 113-acre Los Angeles Zoo site in Griffith Park. The actual location of the plant is adjacent to the Golden State Freeway (west side) just south of the Ventura Freeway (Figure VI-1). This treatment facility is owned by the City of Los Angeles, Department of Recreation and Parks.

The collection system for the LAZTP consists of an animal enclosure washdown and storm drain system. The domestic wastewater generated within the zoo complex is not treated by the LAZTP but is discharged to an off-site City sewer which connects to the North Outfall Sewer.

The animal pond drainage system collects the water from the various animal ponds located throughout the zoo complex. On the average, these ponds are drained twice a day. The water from these ponds contains animal waste and can be classified as wastewater.

The combination of animal enclosure washdown and storm drain system collects the washdown waters from each of the animal exhibit areas and onsite surface runoff, both of which contain animal wastes. These flows are conveyed to the LAZTP for treatment. A diversion structure has been constructed in the system to divert dry-weather surface flow and animal enclosure washdown flows to the treatment plant while bypassing high wet-weather surface flows directly to the Los Angeles River.

After primary sedimentation and chlorination, the effluent from the plant is discharged to the Los Angeles River. The sludge collected at the plant is pumped to a City sewer.

2. EXISTING TREATMENT FACILITIES

The existing treatment facilities presently operated by the City are the Hyperion, Terminal Island, Los Angeles-Glendale, and Los Angeles Zoo treatment plants, and the Valley Settling Basin. The Los Angeles-Glendale Water Reclamation Plant is considered operational by this report, and Unit 1 of the Terminal Island Treatment Plant, now under construction, should be operational in 1977. In addition, the City of Burbank operates its own water reclamation plant and discharges the sludge to Los Angeles' sewer system.

The Zoo Treatment Plant is considered a "point-source" discharger, and must operate within the limitations established by a National Pollution Discharge Elimination System (NPDES) permit. The existing permit was issued by the California Regional Water Quality Board, Los Angeles Region, in December 1974, to assure compliance with the Interim Water Quality Control Plan Objectives for the Los Angeles River. The LAZTP, in effect, is not a part of the wastewater treatment facilities of the Bureau of Engineering, and has not been considered in detail in the analyses performed for this EIS. Performance analyses of the operational treatment facilities will follow in Section VI-C.2.

a. Hyperion Treatment Plant. By far the largest treatment facility in the planning area, the Hyperion Treatment Plant (HTP), can provide primary treatment to an average influent flow of 420 mgd. In addition, secondary treatment is provided for approximately 100 mgd of primary treated effluent. Although the facilities on the 144-acre site are extensive, the plant processes basically consist of pretreatment, primary and secondary treatment, sludge treatment and discharge to Santa Monica Bay. Figure VI-14 is a simplified schematic flow diagram of the plant. Specific design data and loadings for the various processes discussed below can be found in Table VI-4.

(1) PRETREATMENT. Influent from the four interceptor sewers previously discussed is directed to an east and west headworks system where coarse debris and grit are removed. Plant influent is regulated by a system of valves, gates and a splitter structure so that the East Headworks normally receives 65 percent and the West Headworks 35 percent of the total influent wastewater. In case of an in-plant failure, all or a part of the total influent can be diverted to a bypass conduit for discharge to the Bay.

The influent to the East Headworks is composed of the total flow in the NCOS and a portion of the combined flows of the NOS and COS. Coarse material is removed from the influent by four mechanically-raked bar screens. After screening, the flow enters three horizontal-flow grit chambers where sand and heavier mineral matter are removed. The West Headworks normally receives all flow from the CIS and also a portion of the combined COS-NOS flow. In this system, three mechanically-raked bar screens and two aerated grit tanks are utilized to remove coarse and finer solids. The solid material removed from the influent in each headworks is transported by truck to a sanitary landfill. After these pretreatment processes, both headworks effluents enter the primary sedimentation tanks.

(2) PRIMARY TREATMENT. The 12 primary sedimentation tanks at the HTP are divided into three batteries of four tanks each: East, Central and West. The East and Central batteries receive effluent from the East Headworks while West Headworks effluent flows into the West battery of sedimentation tanks. With the exception of a pre-aeration process in the East and Central batteries, the primary treatment in all 12 tanks is essentially the same.

During an average detention time of approximately one hour and twenty minutes, approximately 60 percent of the suspended solids of the influent settles to the bottom of the sedimentation tanks. Wooden flights attached to continuous chains are dragged the length of the floor of each tank to transport the settled solids to a sump at the inlet end of the tank. On their return, the flights ride at the water surface carrying grease and other floating material to grease skimmers at the opposite end of the sedimentation tanks. The settled solids, grease and other floatable material are then conveyed to the plants' sludge digestion and treatment facility. The primary effluent from the West battery and all but 100 mgd of that from the East and Central Batteries is piped to the plants' effluent pumping facility for discharge. The remaining 100 mgd is piped to the aeration tanks of the secondary treatment process.

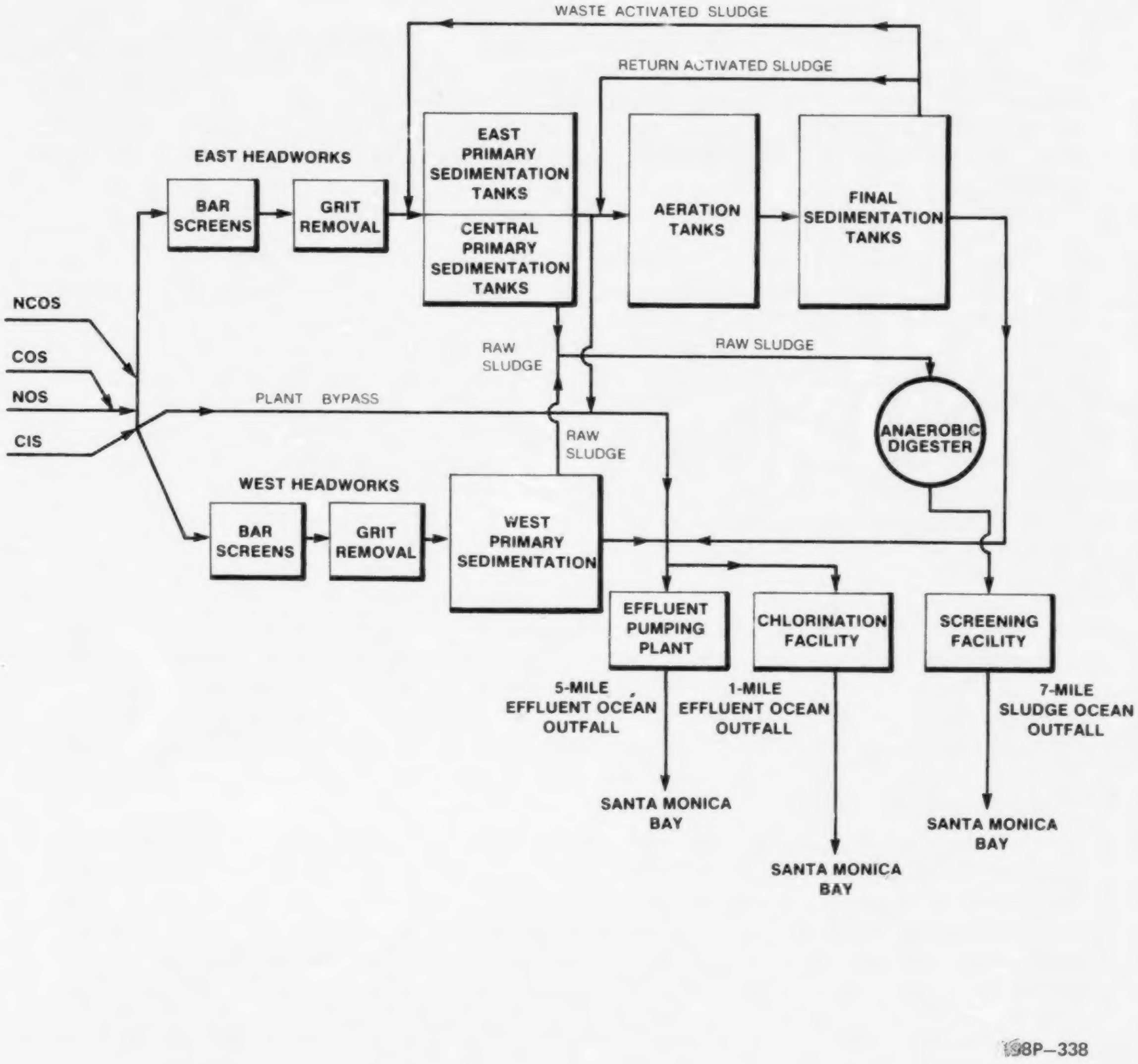
WASTE ACTIVATED SLUDGE
RETURN ACTIVATED SLUDGE
EAST HEADWORKS
BAR SCREENS
GRIT REMOVAL
EAST PRIMARY SEDIMENTATION TANKS
CENTRAL PRIMARY SEDIMENTATION TANKS
AERATION TANKS
FINAL SEDIMENTATION TANKS
NCOS
COS
NOS
CIS
RAW SLUDGE
RAW SLUDGE
PLANT BYPASS
RAW SLUDGE
ANAEROBIC DIGESTER
WEST HEADWORKS
BAR SCREENS
GRIT REMOVAL
WEST PRIMARY SEDIMENTATION
EFFLUENT PUMPING PLANT
CHLORINATION FACILITY
SCREENING FACILITY
5-MILE EFFLUENT OCEAN OUTFALL
1-MILE EFFLUENT OCEAN OUTFALL
7-MILE SLUDGE OCEAN OUTFALL
SANTA MONICA BAY
SANTA MONICA BAY
SANTA MONICA BAY
98P–338

Figure VI-14. Simplified flow diagram of the Hyperion Treatment Plant (Bureau of Engineering, 1976).

Table VI-4. Summary of existing and committed plant design capacities and levels of treatment.

PLANT	STATUS	DESIGN CAPACITY (AVERAGE FLOW, MGD)				PERCENT OF TOTAL CAPACITY	
		PRIMARY	SECONDARY	TERTIARY	TOTAL	IN BEING	COMMITTED
HTP	Operational	420	100	0	420	96.6	89.2
TITP	Operational	14	0	0	14	3.2	N/A
VSB	Semi-Operational[5]	1.0	1.0	0	1	0.2	0.2
Zoo	Operational	2.5[1]	0	0	--[1]	N/A	N/A
LA/GWRP	Under Construction	20	20	20[3]	20[2]	--	4.2
TITP Unit I	Under Construction	30	30	0	30[4]	--	6.4
TOTAL	Operational	435	101	0	435[6]		
TOTAL	Operational & Under Construction	461	121	20	471		

[1] Animal wastes only. Not considered in total capacity.

[2] Of the 20 mgd capacity at LA/GWRP, Los Angeles and Glendale each hold rights to 10 mgd. The total of 20 mgd has been included here because it is derived from the Hyperion Service area.

[3] Filtration, chlorination, and retentions in a chlorine contact pond.

[4] Will replace existing TITP.

[5] Not considered "operational," but treats wastewater otherwise tributary to Hyperion.

[6] Not including capacity at the City of Burbank, which is not operated under the jurisdiction of the City of Los Angeles.

(3) SECONDARY TREATMENT. The activated sludge process is used at HTP to treat the 100 mgd of primary treated effluent. Basically, the process consists of bringing a concentrated zoological mass, activated sludge, in contact with the incoming flow for a period of time while oxygen is introduced to accomplish the purification process. Stabilization of the organic materials is effected and the resultant solids are separated from the purified liquid in sedimentation tanks.

Activated sludge contact and oxygenation take place in 32 aeration tanks. After an average detention time of approximately 8 hours, the mixed liquor from the aeration tanks is distributed to 20 uncovered, final sedimentation tanks. During an average detention time of approximately 5 hours in these tanks, the sludge settles to the bottom and the water, substantially free of organic matter, flows out over weirs and is conveyed to the effluent pumping facility. The biologically active, aerobic, activated sludge is removed by mechanisms similar to those used in the primary system. Sludge, in excess of the amount needed for the process, is returned to the head of the primary sedimentation system where it is settled, removed with the primary sludge, and conveyed to the sludge digestion and treatment facility.

(4) SLUDGE DIGESTION. All primary sludge, waste activated sludge, grease and other floatables are pumped to the sludge digestion system. This system consists of 18 covered tanks, 12 primary and 6 secondary, where in the absence of atmospheric oxygen, anaerobic bacteria stabilize the organic materials. The bacteria thrive at near body temperature, so heat is provided by the injection of steam into the sludge as it enters the primary digesters. During digestion, about one-half of the solids are transformed to a gas consisting of about two-thirds methane and one-third carbon dioxide. The remaining solids are a stable humus-like material in a semiliquid form.

Following digestion, the sludge flows to the sludge treatment facility where floatable objects are removed by five vibrating screens. The screenings are hauled by truck to a sanitary landfill site while the screened sludge is pumped through the 7-mile outfall.

The existing sludge digestion and treatment facilities are presently being modified with the prime objective of converting the existing secondary digesters to primary digesters and upgrading the sludge treatment facility in a manner which is compatible with present and future plant requirements. Specific data relating to these new facilities are presented in Table VI-5. Figure VI-15 shows the project layout.

(5) · OCEAN DISCHARGE. The primary and secondary treated liquid effluent is discharged through the 5-mile long, 12-foot diameter ocean outfall. This line operates under gravity flow conditions for flows up to 325 mgd with pumping required for flows above that amount. Pumping is provided by three identical pumping units consisting of vertical

Table VI-5. System components of the Hyperion Sludge-Digestion Facility (under construction).

COMPONENT	NUMBER/ CAPACITY
DIGESTOR GAS MIXING SYSTEM	
Number of Digestors	6
Draft Tubes	
Number per digestor	6
Diameter, Ft./In.	4 - 9
Gas Rate, cfm per sq.ft.	29
Gas Injector Pipes	
Number per draft tube	7
Size, inches	3
Compressors	
Number per digestor	1
Capacity, each cfm	3,100
Discharge pressure, psig	7
Horsepower, each	125
PUMPED CIRCULATION SYSTEMS	
Number of Digestors	6
Pumps, Variable Speeds	
Number per digestor	1
Capacity, gpm	
Maximum	1,500
Normal	700
Horsepower	40
Boiler Plants	
Number	1
Size, boiler horsepower	400
Water Softeners	
Number	2
Size, each kilograms	500
SLUDGE TREATMENT FACILITY ENLARGEMENT	
Number of Screens	4
Type-horizontal Differential Scalping	
Size, Each, Ft.	8 x 9
Capacity, Each, GPM	700
UNIT SUBSTATION ENLARGEMENT	
Transformers 4800/480 Volt	1
Number	1,000
Size, KVA	
Feeders, 480 Volt	
Number, 800 amp	3
Number, 100 amp	1

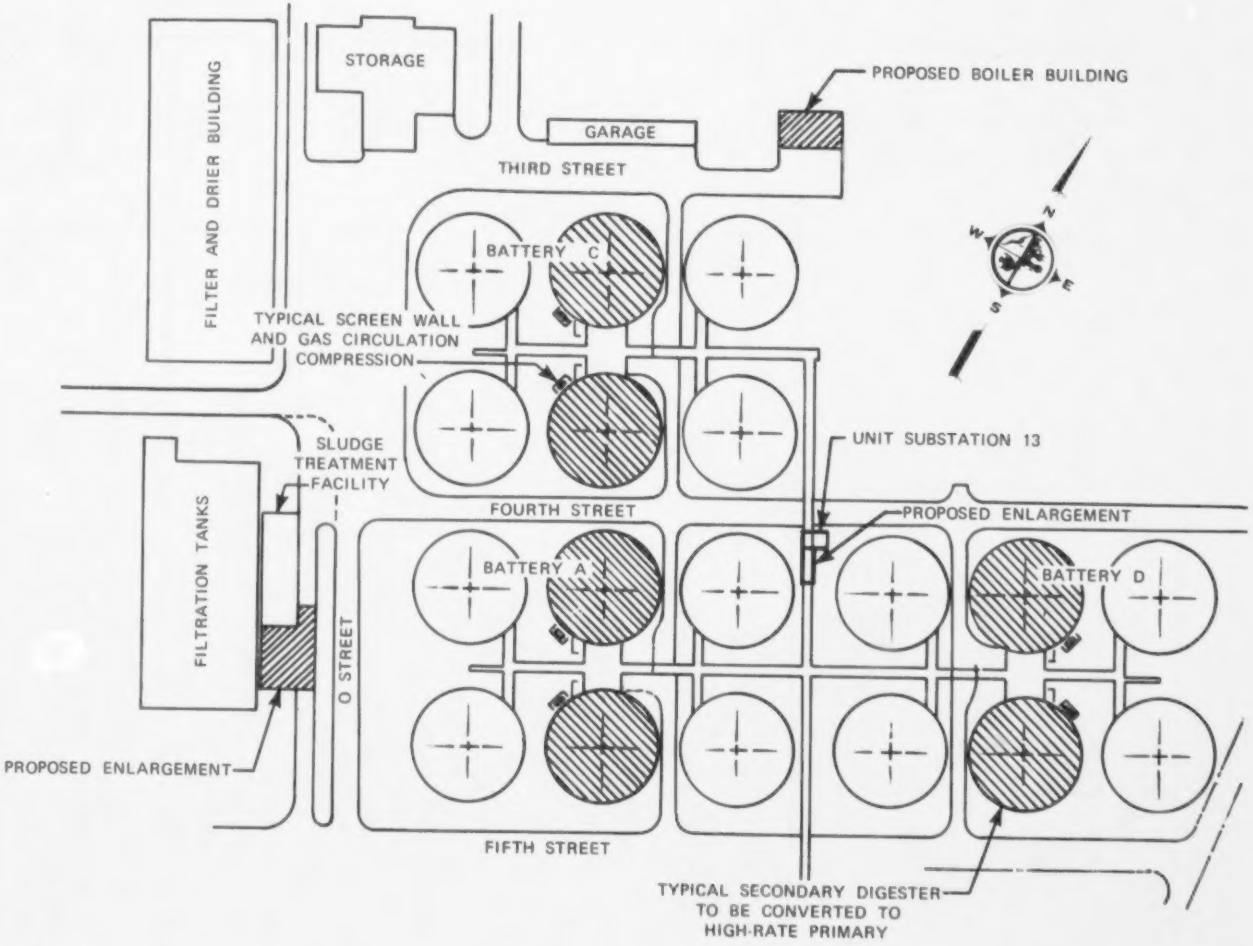
FILTER AND DRIER BUILDING
STORAGE
GARAGE
PROPOSED BOILER BUILDING
THIRD STREET
BATTERY C
TYPICAL SCREEN WALL AND GAS CIRCULATION COMPRESSION
SLUDGE TREATMENT FACILITY
UNIT SUBSTATION 13
FOURTH STREET
PROPOSED ENLARGEMENT
FILTRATION TANKS
BATTERY A
BATTERY D
O STREET
PROPOSED ENLARGEMENT
FIFTH STREET
TYPICAL SECONDARY DIGESTER TO BE CONVERTED TO HIGH-RATE PRIMARY
N
E
S
W

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Figure VI-15. Layout of the Hyperion Treatment Plant Sludge Digestion Facility.

centrifugal pumps and 2,500 horsepower wound rotor electric motors. The pumps have a 60-inch suction intake, 54-inch discharge and are rated at 180 mgd against a 64-foot head. The wound rotor motors are variable speed and are controlled through liquid rheostats. Automatic controls start and stop the pumps and vary the speed to match the flow of treated wastewater. These pumps provide for a total discharge of 630 mgd at maximum output. An additional unit will soon be installed to provide for a total peak discharge of 740 mgd.

The outlet of the 5-mile outfall consists of two identical 4,000-foot long diffuser legs in 180 feet of water. These legs are in the form of a wye and vary in diameter from eight and one-half feet to six feet. The diffusers have many small ports in their circumference which provide a maximal mixing of the treated effluent with sea water.

The original HTP ocean outfall, the 1-mile long, 12-foot diameter line, is now maintained only for plant emergencies. It is a gravity line having eight discharge ports at a depth of 45 feet.

The seven-mile long, 20-inch diameter sludge outfall extends to the head of Santa Monica Canyon and discharges at a depth of 320 feet. The canyon itself leads to the Santa Monica Basin which is approximately one-half mile deep.

b. Terminal Island Treatment Plant (Existing). The treatment facilities at Terminal Island are presently being upgraded. Existing facilities are capable of treating 14 mgd with the treatment processes consisting of pretreatment, primary treatment, sludge digestion and drying, and discharge to Los Angeles Outer Harbor. Figure VI-16 is a schematic diagram of the flow at Terminal Island. Funds are committed, and this plant will be upgraded to full secondary treatment. An EIS on the entire TITP expansion program is being prepared, and a separate EIS is being prepared on effluent disposal. Although TITP operates as a completely isolated unit of the complex Los Angeles system, it has been considered in this study. Detailed information will be found in the referenced EISs when issued.

(1) PRETREATMENT. The six existing force mains enter the plant's headworks through one common influent line. At the headworks, the influent passes through comminutors where rags and other floatables are pulverized and returned to the flow. After screening, the influent flows through two aerated grit chambers which provide for grit removal and preaeration. Grit is removed manually at weekly intervals with a bucket attached to an overhead crane. Two 650 CFM-capacity blowers, operated alternatively on a monthly basis, provide aeration for the grit chambers. Grit and larger solids removed from the influent in the pretreatment process are transported to a sanitary landfill.

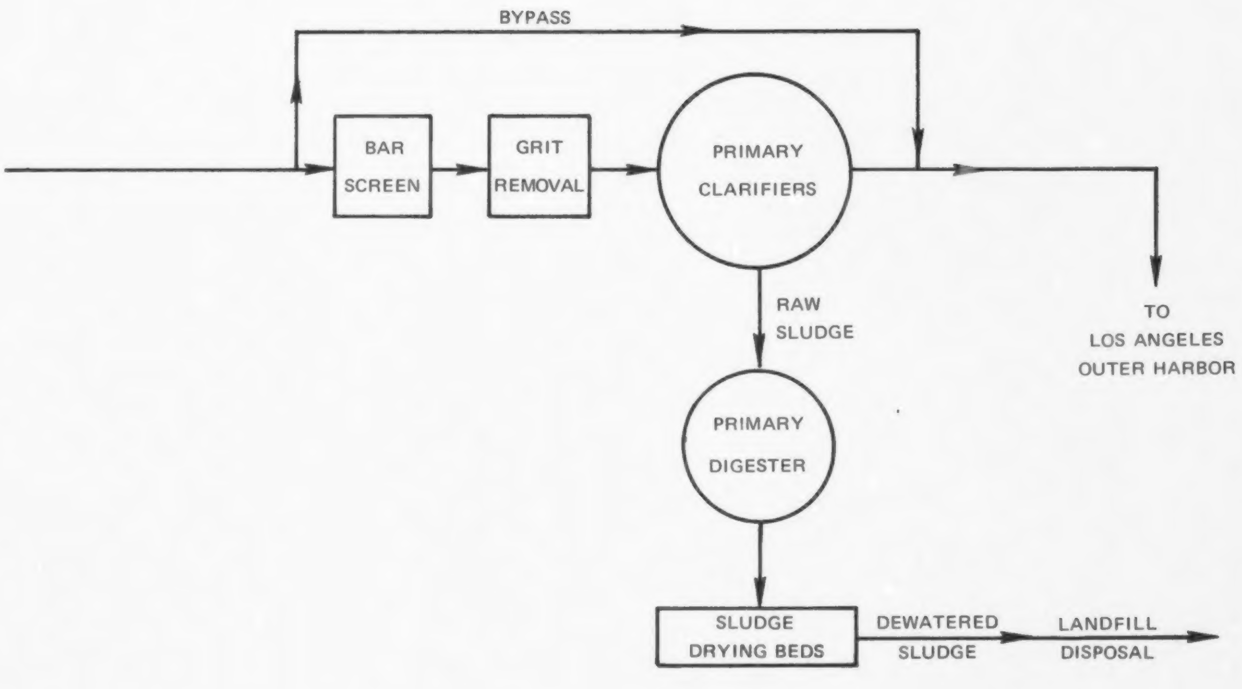

BYPASS
BAR SCREEN
GRIT REMOVAL
PRIMARY CLARIFIERS
TO LOS ANGELES OUTER HARBOR
RAW SLUDGE
PRIMARY DIGESTER
SLUDGE DRYING BEDS
DEWATERED SLUDGE
LANDFILL DISPOSAL
198P–340

Figure VI-16. Simplified flow diagram of the existing Terminal Island Treatment Plant (Department of Engineering, 1976).

(2) PRIMARY TREATMENT. After grit removal and aeration, the pretreated effluent enters two cylindrical primary sedimentation tanks where the flow moves radially outward from the center of the tanks. Settled sludge is moved toward a sump in the center of the tanks by sweep arm mechanisms while surface scum is removed by rotating arm mechanisms. Settled sludge and surface scum is conveyed to the plant's sludge digestion system.

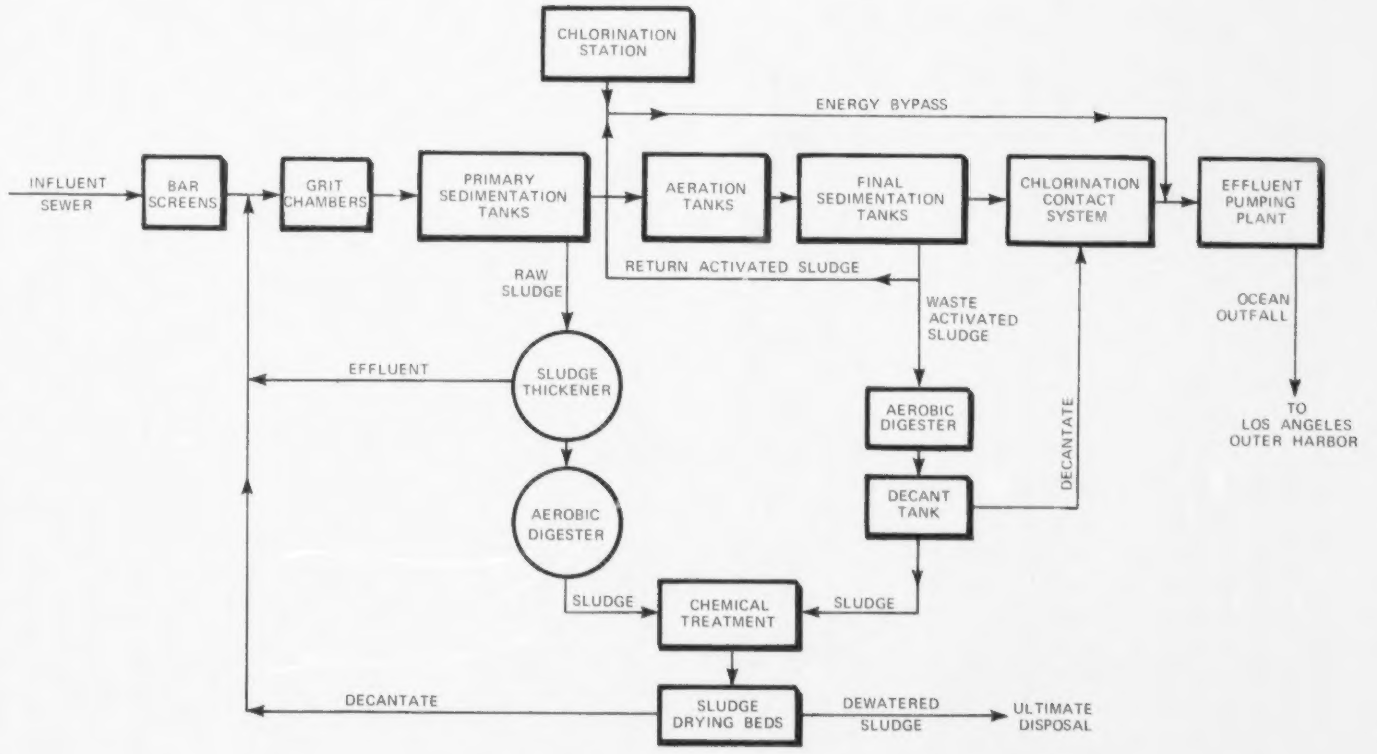
(3) SLUDGE DIGESTION AND DRYING. Anaerobic digestion takes place in a 100-foot diameter cylindrical tank in an average detention time of 40 days. The digested sludge, which is very wet, is discharged once a week to drying beds. Upon sufficient dewatering, the sludge cake is transported to a sanitary landfill.

(4) HARBOR DISCHARGE. The primary treated effluent from the sedimentation tanks flows through a Parshall flume and the plant's 39-inch diameter, 1,500-foot long outfall to a point in the outer harbor approximately 450 feet offshore. A bypass structure is available in case of a plant failure to divert all plant inflow directly to the harbor outfall.

c. Terminal Island Treatment Plant, Unit I. The upgraded Terminal Island Treatment Plant, Unit I, is capable of providing secondary treatment to an average flow of 30 mgd. The influent from the six existing force mains and the soon-to-be-completed San Pedro Interceptor will be subjected to pretreatment, secondary treatment, sludge digestion and drying, and harbor discharge. Figure VI-17 is a diagram of the flow at the new facilities.

(1) PRETREATMENT. The new facilities process involves the removal of heavier solid material from the influent by two mechanically raked bar screens. This removed material and washed grit from two aerated grit chambers is transported to a sanitary landfill. The pretreated effluent is then distributed to six primary sedimentation tanks.

(2) PRIMARY TREATMENT. The six rectangular primary sedimentation tanks operate similarly to those at the Hyperion Treatment Plant. Wooden flights transport approximately 60 percent of the suspended solids to the inlet end of each tank while grease and other floatables are skimmed to the opposite ends. The raw sludge, grease, and other floatables are then removed from the tanks and conveyed to sludge digesters while the primary effluent enters the aeration tanks of the secondary treatment process.



CHLORINATION STATION
ENERGY BYPASS
INFLUENT
SEWER
BAR SCREENS
GRIT CHAMBERS
PRIMARY SEDIMENTATION TANKS
AERATION TANKS
FINAL SEDIMENTATION TANKS
CHLORINATION CONTACT SYSTEM
EFFLUENT PUMPING PLANT
RETURN ACTIVATED SLUDGE
RAW SLUDGE
WASTE ACTIVATED SLUDGE
OCEAN OUTFALL
EFFLUENT
SLUDGE THICKENER
AEROBIC DIGESTER
DECANTATE
TO LOS ANGELES OUTER HARBOR
AEROBIC DIGESTER
DECANT TANK
SLUDGE
CHEMICAL TREATMENT
SLUDGE
DECANTATE
SLUDGE DRYING BEDS
DEWATERED SLUDGE
ULTIMATE DISPOSAL

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Figure VI-17. Simplified flow diagram of Terminal Island Treatment Plant, Unit I (Bureau of Engineering, 1976).

(3) SECONDARY TREATMENT. Terminal Island's secondary process will be essentially the same as at Hyperion. Here the activated sludge process will involve activated sludge contact and oxygenation in nine aeration tanks. The stabilized organic materials will be separated from the mixed liquor in 18 final sedimentation tanks. Prior to discharge, the effluent will be chlorinated in a 1,240-foot long, double-box conduit. A portion of the sludge obtained will be returned to the head of the aeration tanks with the remainder going to the sludge digestion facility.

(4) SLUDGE DIGESTION AND DRYING. The raw sludge from the primary facilities will be conveyed to a gravity sludge thickener. Here the sludge will be concentrated and the supernatant drawn off and conveyed to the head of the grit chambers. The thickened raw sludge will be conveyed to the anaerobic digester of the existing facility.

Initially in its operation, some of the aeration tanks of the secondary system will be used as aerobic digesters for waste activated sludge. After aerobic digestion, the sludge will be conveyed to two of the 18 final sedimentation tanks for decantation on a temporary basis. The decantate drawn from these tanks will be chlorinated and discharged with the secondary effluent. The temporary use of the existing anaerobic digestion facility and the secondary aeration and sedimentation tanks in the sludge digestion process will cease upon completion of proposed Unit II improvements at Terminal Island Treatment Plant.

Sludge from both the anaerobic digestion facility and the two decantation tanks will be chemically treated prior to discharge to sludge drying beds. Here the mixture will be dried to a moisture content of 25 percent or greater with the sludge being disposed of in a sanitary landfill and the removed decantate conveyed back to the influent line of the grit chambers.

(5) HARBOR DISCHARGE. A pumping plant is being constructed with Unit I to provide sufficient peak discharge capacity to the outer harbor and also standby capability. Three variable-speed pumps are being installed which will connect to a 48-inch diameter outlet conduit. This large line will initially connect to the existing 39-inch outfall and ultimately to a new ocean outfall which will comply with state and federal regulations.

d. Los Angeles-Glendale Water Reclamation Plant. The Los Angeles-Glendale Water Reclamation Plant (LAGWRP) is the City's first operational reclamation facility and is designed to provide tertiary treatment for an average flow of 20 mgd.

A regulated diversion structure in the NOS diverts flow to the plant, and most captured solids removed from the influent are returned to and conveyed by the NCOS-NOS system to Hyperion. The processes at LAGWRP consists of pretreatment; primary, secondary, and tertiary treatment; chlorination; and discharge. Figure VI-18 is a flow diagram for LAGWRP.

(1) PRETREATMENT. Three mechanically raked bar screens comprise the pretreatment at LAGWRP. After rags and other coarse material are removed from the influent, the flow is pumped to the primary sedimentation tanks.

(2) PRIMARY TREATMENT. The eight primary sedimentation tanks at LAGWRP operate similarly to those discussed previously. Approximately 60 percent of the settled solids are removed and returned to the NOS while the effluent flows to the aeration tanks of the secondary system.

(3) SECONDARY TREATMENT. Similarly to the other treatment facilities, LAGWRP uses the activated sludge process in its secondary treatment. Six aeration tanks and ten final sedimentation tanks further reduce suspended solids and stabilize the effluent. That portion of the resultant activated sludge that is not used in the treatment process is returned to the NOS while the secondary effluent is conveyed to the tertiary facilities.

(4) TERTIARY TREATMENT. Three 41-foot diameter cylindrical filters provide tertiary treatment at LAGWRP. The filters are of mixed media, remove residual suspended solids, and produce an effluent which can be effectively chlorinated. The backwash from the filters are returned to the NOS.

(5) CHLORINATION AND DISCHARGE. As a final touch, the tertiary treated effluent is brought into contact with chlorine in a large pond on site. After a detention time of approximately 1.5 hours, portions of the high quality effluent are either used for irrigation, cooling water for steam plants, or other suitable uses. That portion of the effluent for which a use cannot be found is discharged into the Los Angeles River.

e. Burbank Water Reclamation Plant. This water reclamation plant is owned and operated by the City of Burbank. It serves two beneficial functions for the City of Burbank: (1) it reduces the quantity of wastewater discharging to the City of Los Angeles, thereby reducing their costs of transportation and treatment; and (2) it provides a high quality effluent that can be used as a source of cooling makeup water for its adjacent power generation facility. The suspended solids captured are conveyed to the City of Los Angeles' wastewater system for eventual conveyance to the Hyperion Treatment Plant for reprocessing and removal. The water reclamation plant is designed to provide secondary treatment followed by filtration and chlorination for an average flow rate of 9 mgd. The processes of the Burbank Water Reclamation Plant consist of primary, secondary, and tertiary treatment, chlorination, and discharge.

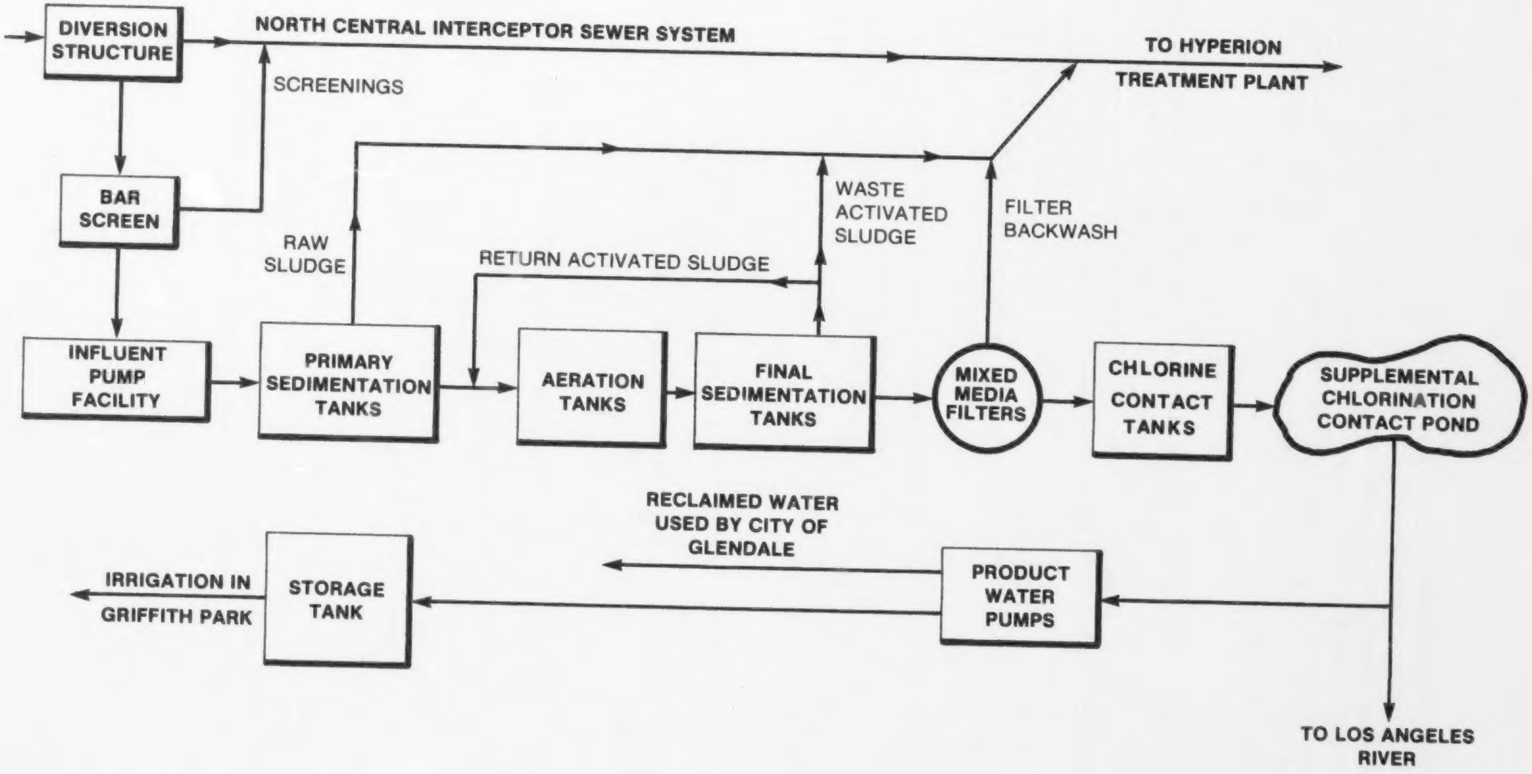
DIVERSION STRUCTURE
NORTH CENTRAL INTERCEPTOR SEWER SYSTEM
TO HYPERION TREATMENT PLANT
SCREENINGS
BAR SCREEN
RAW SLUDGE
RETURN ACTIVATED SLUDGE
WASTE ACTIVATED SLUDGE
FILTER BACKWASH
INFLUENT PUMP FACILITY
PRIMARY SEDIMENTATION TANKS
AERATION TANKS
FINAL SEDIMENTATION TANKS
MIXED MEDIA FILTERS
CHLORINE CONTACT TANKS
SUPPLEMENTAL CHLORINATION CONTACT POND
RECLAIMED WATER USED BY CITY OF GLENDALE
IRRIGATION IN GRIFFITH PARK
STORAGE TANK
PRODUCT WATER PUMPS
TO LOS ANGELES RIVER

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Figure VI-18. Simplified flow diagram of the Los Angeles-Glendale Water Reclamation Plant (Bureau of Engineering, 1976).

(1) PRIMARY TREATMENT. The three primary sedimentation tanks at the Burbank Water Reclamation Plant will operate similarly to those discussed previously. Approximately 60 percent of the settled solids and 35 percent of the BOD will be removed and returned to the 12-inch sewer adjacent to the plant and subsequently discharged to the NOS (City of Los Angeles Wastewater System). The primary effluent will flow to the aeration tanks of the secondary system.

(2) SECONDARY TREATMENT. Similarly to the other treatment facilities, the Burbank Water Reclamation Plant uses the activated sludge process in its secondary treatment process units. Four aeration tanks and six final sedimentation tanks are used to further reduce suspended solids and BOD. That portion of the resultant activated sludge that is not used in the treatment process is returned to the 12-inch sewer adjacent to the plant, while the secondary effluent is conveyed to the tertiary facilities.

(3) TERTIARY TREATMENT. Three cylindrical filters provide tertiary treatment at the Burbank Water Reclamation Plant. The filters are of dual media and will remove residual suspended solids and produce an effluent which can be effectively chlorinated. The backwash from the filters is returned to the 12-inch sewer.

(4) CHLORINATION AND DISCHARGE. The filtered effluent is brought into contact with chlorine in contact tanks on site. The high quality effluent is used for cooling makeup water and, if necessary, can be discharged to the Burbank Wash.

f. Valley Settling Basin. As a training and experimental facility, the Valley Settling Basin is not considered to be an operational part of the City's wastewater treatment system. The plant consists basically of dual primary and secondary systems with influent to each pumped from the NOS through a common bar screen. Bar screenings, waste activated sludge and any effluent not used for irrigation or experimental purposes are returned to the NOS.

The dual secondary facilities utilize different aeration techniques in their activated sludge processes. In one, mechanical aeration is used while diffused air is used in the other. Tests are being performed to determine the efficiencies of each as compared to other methods of oxygen transfer.

g. Los Angeles Zoo Treatment Plant. Unlike the other municipal wastewater treatment facilities discussed thus far, the treatment facility at the Los Angeles Zoo can be considered as a discrete source of wastewater to the NOS and the Los Angeles River. Also, all wastewater from the Zoo may be conveyed directly to the LAGWRP in the future. Currently, as a discrete wastewater discharger, the City's Department of Recreation and Parks operates the facility under a NPDES permit issued by the California Regional Water Quality Control Board-Los Angeles Region.

The Los Angeles Zoo Treatment Plant has the capability of providing primary treatment to a maximum of 2.5 mgd through the use of two, 40-foot diameter clarifiers. During dry-weather flows, waste from animal ponds and animal enclosures is settled for an average detention time of two hours in the clarifiers. The resultant sludge is pumped to the NOS while the primary effluent passes through a proportional-feed chlorinator prior to discharge to the Los Angeles River. As discussed earlier, during high, wet-weather flows, wastewater from the animal enclosures flows untreated to the Los Angeles River along with storm runoff from the hills surrounding the Zoo.

C. existing and projected water and wastewater requirements and characteristics

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C. EXISTING AND PROJECTED WATER AND WASTEWATER REQUIREMENTS AND CHARACTERISTICS

1. PROJECTED WATER SUPPLY NEEDS

Inasmuch as local water supplies are relatively limited and Colorado River water supplies will soon be reduced, any future demand will have to be satisfied by additional importation. In addition to changing the quantity of water, increased importation will significantly affect water quality.

Presently, the MWD supply offsets the deficit between present demands and Owens River and local water supply. However, additional importation will be required to accomodate the projected population, particularly with the reduction in Colorado River entitlement to MWD. The required quantities of additional water supply will depend to some extent on the increase in direct use of reclaimed water. Availability of SWP water will be necessary to offset the anticipated reduction in Colorado River water supplies.

The continued beneficial use of groundwater supplies will be contingent upon correction of the deteriorating conditions described previously. A model developed by the DWP for the San Fernando Basin predicts that average groundwater TDS values will continue to rise for the next ten to fifteen years before equilibrium is reached at a TDS concentration approximately 125 mg/l higher than present levels. The basin-wide average TDS is estimated to reach steady state at a concentration of about 710 mg/l.

Alternative groundwater management plans that have been considered include:

- Selective pumping to increase salt outflows from the base without altering inflows.
- Use of unused storage capacity of the groundwater basin to store excess State Project water for future use.
- Use of reclaimed water at various locations.

Recently, the State Department of Water Reources has proposed the use of reserve space in the San Fernando Basin for the storage of SWP water. The proposal recommends that approximately one half million acre-feet of water be pumped into the Basin over a period of five years. It is expected that this project will cause groundwater levels in the San Fernando Valley to rise, but not to the historically high levels that existed in the early 1940s.

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The MWD assumes constant future TDS concentrations of Colorado River and State Project waters at 750 and 250 mg/l, respectively. However, the Basin Plan contractor estimates a substantially higher future TDS for the Colorado River water of 850 mg/l presently to 1,250 mg/l (Imperial Dam) in the year 2000.

2. EXISTING AND PROJECTED WASTEWATER FLOWS

The San Fernando Valley system subarea is tributary to the North Outfall Sewer-La Cienega-San Fernando Valley Relief Sewer (NOS-LCSFVRS) Interceptor Sewer System upstream tunnel portal through the Hollywood Hills. This tributary point is significant because the NOS-LCSFVRS Interceptor Sewer System is nearing peak capacity. Thus, with only minimal growth in the San Fernando Valley, the capacity of this sewer will soon be exceeded. Sufficient flow records are not available to make a direct per capita flow determination for this subarea. However, a reasonably accurate estimate can be made utilizing the City of Los Angeles, Bureau of Engineering, Sewer Design Manual. From Table VI-6 the average per capita contribution is 117.2 gpcd. For the purpose of projecting flows, a value of 115 gpcd will be used.

The Los Angeles-Glendale Water Reclamation Plant (LAGWRP) system subarea derives its flows from the cities of Los Angeles, Glendale and Burbank. A portion of La Crescenta will also be served by the LAGWRP within the planning period. The flows from Los Angeles are from the portion of the San Fernando Valley not tributary to the NOS-LCSFVRS Interceptor Sewer System and, from the previous discussion, will be assigned a per capita rate of 115 gpcd.

The flows generated from Glendale and Burbank are established from numerous gaugings. Tables VI-7 and VI-8 indicate the recorded wastewater flows from Glendale and Burbank, respectively, for fiscal year 1974-1975. From Table VI-8, the average flow measured from the City of Glendale was 13.5 mgd. Based on a sewered population of 87,298, the per capita flow rate is 155 gpcd.

Most of the La Crescenta area is presently unsewered, however, provisions must be made to provide sewerage service to that portion which is served by the Crescenta Valley Water District. Flow measurements are not available. However, since this area is characterized primarily by residential development with light industrial and commercial uses, an estimated per capita sewage contribution of 100 gpcd appears to be reasonable.

The third system subarea is that area which is directly tributary to the HTP, HTP (Direct) System Subarea. The measured flows available are those recorded at the HTP which include flows from the entire Hyperion System with La Crescenta not being served and is calculated to be 125 gpcd. Table VI-9 illustrates the method of determining the per capita contribution for the HTP system subarea.

Table VI-6. Determination of per capita flow generation for the San Fernando Valley.

1.	Area developed or can be developed, acres	150,000	
2.	1975 Population Estimate	907,559	
3.	Domestic		
	Population x 85 gpcd, mgd		77.1
4.	Industrial		
	Percentage of Total Area	3.52%	
	Percentage Developed	51 %	
	Flow Co-efficient, C, mgd/ac.	0.005168	
	Total Flow, mgd		13.9
5.	Commercial		
	Percentage of Total Area	2.75%	
	Percentage Developed	51 %	
	Flow co-efficient, C, mgd/ac.	0.003876	
	Total Flow, mgd		8.2
6.	Hospitals		
	Number of Hospitals	23	
	Flow co-efficient, C, mgd/ac.	0.25	
	Total Flow, mgd		5.8
7.	Colleges/Universities		
	Number of Institutions	6	
	Flow co-efficient, C, mgd/ac.	0.24	
	Total Flow, mgd		1.4
8.	TOTAL FLOW, mgd		106.4
9.	PER CAPITA FLOW (8/2), mgd		117.2

NOTES: a. Flow co-efficients: C, from City of Los Angeles, Bureau of Engineering, Sewer Design Manual.

b. Percentage of area zoned for commercial and industrial use per City of Los Angeles Planning Department.

Table VI-7. Recorded wastewater flows from City of Glendale tributary to Los Angeles-Glendale Water Reclamation Plant, fiscal year 1974-1975.

	GAUGING STATION FLOWS (cfs)							
MONTH	DORAN ST.	COLORADO ST.	ELK AVE.	LAKE ST. PUMP PLANT	TOTAL CFS	TOTAL MGD	DAYS	MG/MONTH
July	9.68	8.04	2.24	1.42	21.38	13.82	31	428.42
August	9.08	8.66	2.84	1.58	22.16	14.32	31	443.92
September	10.20	6.70	2.00	1.42	20.32	13.13	30	393.90
October	8.05	8.35	2.46	1.46	20.32	13.13	31	407.03
November	8.99	7.93	2.32	1.30	20.54	13.28	30	398.40
December	8.04	7.93	2.68	1.31	19.96	12.90	31	399.90
January	9.13	7.51	2.40	1.19	20.23	13.07	31	405.17
February	9.79	8.42	2.06	1.48	21.75	14.06	28	393.68
March	9.45	8.71	2.17	1.26	21.59	13.95	31	432.45
April	9.24	7.58	2.11	1.51	20.44	13.21	30	396.30
May	11.14	7.26	2.35	1.52	22.27	14.39	31	446.09
June	8.83	7.26	2.22	1.32	19.63	12.69	30	380.70
TOTAL								4,925.96
Average MGD								13.50

Sewered Tributary Population = 87,298

Per Capita Flow = $\frac{13.5 \times 10^6}{87,298}$ = 155 gpcd

Table VI-8. Recorded wastewater flows from City of Burbank tributary to Los Angeles-Glendale Water Reclamation Plant, fiscal year 1974-1975.

MONTH	SUM OF UPPER AND LOWER GAUGING STATIONS (cfs)	MGD
July	8.32	5.37
August	11.63	7.51
September	11.85	7.66
October	11.85	7.66
November	12.06	7.79
December	11.30	7.30
January	11.82	7.64
February	12.70	8.20
March	11.99	7.75
April	11.52	7.44
May	10.87	7.02
June	12.17	7.86
TOTAL MGD		89.20
Average MGD		7.43

Burbank Ungauged Flow (Estimated) = 0.02 MGD

Table VI-9. Determination of HTP (direct) system subarea per capita wastewater generation.

SYSTEM SUBAREA	COMPONENT	POPULATION	GPCD	FLOW, MGD
LAGWRP	Glendale	87,298	155	13.5
	Burbank	39,440	189	7.5
	Los Angeles	3,464	115	0.4
	Unsewered	37,276		
	Total	167,478		21.4
San Fernando Valley	Sewered	907,559	115	104.4
	Unsewered	97,200		
	Total	1,004,759		104.4
HTP (Direct)	HTP System	3,053,429		352.3
	LAGWRP	-167,478		-21.4
	San Fernando Valley	-1,004,759		-104.4
	Unsewered	-24,734		
	BWRP*	-50,625		
	Total	1,805,833		226.5

Per Capita Flow = 226,500,000/1,805,833 - 125.4 gpcd

* Population served by the Burbank Water Reclamation Plant (BWRP).

Although unsewered areas exist throughout the HTP system, the majority of the unsewered population is located in the San Fernando Valley System Subarea. Census data (1970) provided the number of occupied housing units with public sewers and the total occupied housing units. This information and census tract populations were used to derive the unsewered population in each of the system subareas. This method of estimating unsewered population was corroborated by examination of permit records and field investigations in the SWRP subarea.

Before the existing and projected wastewater flows for the entire Hyperion System are tabulated for reference and later use, other factors which may affect the flows must be considered. For instance, the population projections include the population of that area tributary to the Burbank Water Reclamation Plant (BWRP). This population will have to be deleted prior to determination of system flows for future hydraulic design.* The difficulty here is in estimating what this population figure will be in future years.

The City of Burbank contributes approximately 6.6 mgd to the City of Los Angeles collection system and treats about 4.7 mgd at the BWRP. Recently, a 3-mgd module was added to the plant which increased the total plant capacity to 9 mgd. In addition, wastewater collection system improvements in the BWRP tributary area will soon transport additional flow. Using flow and population data, the per capita wastewater generated in the portion of Burbank tributary to the Los Angeles system was estimated to be 189 gpcd. However, the additional flow to be treated at the BWRP will remove a large quantity of residential flow from the portion of Burbank tributary to Los Angeles and will result in a per capita flow of 330 gpcd in this highly industrialized area.

Considering all of the foregoing discussion, Tables VI-10 and VI-11 indicate the wastewater flow projections for the Hyperion System. Table VI-10 represents the flows estimated under the SCAG '76 population projection, and Table VI-11 utilizes the DOF E-O population projection.

3. EXISTING AND PROJECTED TREATMENT FACILITY DESIGN LOADINGS

Future wasteloads in the planning area were computed by adding to the existing wasteloads (1975) the incremental loads due to projected population increases. Specifically, population increases were multiplied by unit wasteload coefficients for each study area to yield future treatment plant flows. Wastewater solids removed in the upstream plants within the HTP system are proposed initially to be returned to the HTP collection system and to become part of the HTP influent. Analysis of wasteloads at the HTP considered the effects of such contributions from

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* However, to determine the solids treatment design for LAGWRP and HTP the population served by the BWRP must be included since the solids from the BWRP are discharged to the HTP collection system.

Table VI-10. Projected wastewater flows in the Hyperion Treatment Plant system (SCAG-76).

SYSTEM SUB-AREA	1975[1]	1980	1985	1990	1995	2000
San Fernando Valley						
Population[2]	907,559	971,132	1,014,568	1,058,004	1,099,971	1,141,938
Flow (mgd)	104.4	111.7	116.7	121.7	126.5	131.3
LAGWRP						
Population[2,3]	130,202[4]	136,179	140,679	145,179	150,641	156,103
Flow (mgd)	21.4	22.0	22.6	23.3	24.0	24.8
Balance of Hyperion System						
Population[2]	1,805,833	1,831,979	1,877,637	1,923,295	1,956,129	1,988,962
Flow (mgd)	225.7	229.0	234.7	240.4	244.5	248.6
5-Day, 5-Week Increase (6.3%)						
Flow (mgd)	22.1	22.8	23.6	24.3	24.9	25.5
Infiltration	10.0	10.0	10.0	10.0	10.0	10.0
Total Required Capacity (mgd)	383.6	395.5	407.6	419.7	429.9	440.2

[1] Actual average flow for 1975 was 9.2 mgd less than value derived from this table.
[2] From 1980-2000, includes incremental decrease of unsewered population.
[3] Includes population reduction due to increased capacity at the Burbank Water Reclamation Plant.
[4] Population equivalent of 6 mgd Burbank Water Reclamation Plant is excluded.

Table VI-11. Projected wastewater flows in the Hyperion Treatment Plant system (DOF E-0).

SYSTEM SUB-AREA	1975[1]	1980	1985	1990	1995	2000
San Fernando Valley (sewered)						
Population[2]	907,559	887,096	886,431	885,766	905,670	925,574
Flow (mgd)	104.4	102.0	102.0	101.9	104.2	106.5
Los Angeles-Glendale Plant						
Population[2,3]	130,202[4]	126,823	125,853	124,883	125,537	126,190
Flow (mgd)	21.4	20.5	20.3	20.1	20.1	20.2
Balance of Hyperion System						
Population[2]	1,805,833	1,731,422	1,692,912	1,654,402	1,631,190	1,607.978
Flow (mgd)	225.7	216.4	211.6	206.8	203.9	201.0
5-Day, 5-Week Increase (6.3%)						
Flow (mgd)	22.1	21.4	21.0	20.7	20.7	20.6
Wet Year Infiltration (mgd)	10.0	10.0	10.0	10.0	10.0	10.0
Total Flow (mgd)	383.6	370.3	364.9	359.5	358.9	358.3

[1] System sub-area estimates based on gpcd values shown in TABLE VI-17. Actual average flow for 1975 was 9.2 mgd less than value derived from this table.

[2] From 1980-2000 includes incremental decrease of unsewered population.

[3] Differs from Chapter III projections due to equivalent population decrease resulting from increased treatment at Burbank Water Reclamation Plant.

[4] Differs from Chapter III projections since population equivalent of 6 mgd BWRP is excluded.

these upstream facilities. Considering all of the previously discussed information, existing and projected wasteloads for the treatment facilities are shown in Tables VI-12, VI-13 and VI-14.

4. EXISTING WASTEWATER CHARACTERISTICS

The constituents found in wastewaters discharged to treatment facility collection systems greatly affect the quality of effluent discharged to receiving waters. Consistently high concentrations of particular chemical constituents usually indicate waste discharge into the collection system by specific industries so the actual concentrations in wastewater vary considerably with the nature of the processing or manufacturing industries in the area. For example, arsenic sources include manufacturers of glass, ceramics, textiles, paint, and pesticides. Boron sources include detergents, cleansing agents, and glue. The metal plating industries contribute chromium, copper, nickel, iron salts, and mineral acids while other industries characteristically discharge high COD and BOD wastes, oils, and grease.

Infiltration and inflow also affect the wastewater quality. Seawater infiltration affects the TDS concentrations, and inflow of stormwaters, particularly at high peak flows, contributes large quantities of suspended solids and increases the amount of BOD.

a. Hyperion Treatment Plant. Of the approximately 352 mgd average flow to the HTP in calendar year 1975 approximately 9 percent is attributed to industrial discharges. Wastewater characteristics describing average flow, BOD, SS, and peak instantaneous flow for fiscal year 1975 are shown in Table VI-15. Concentrations of BOD and SS lie midway between medium and strong domestic wastes which is probably due to industrial waste discharges to the system. Complete chemical analyses of the HTP influent and effluents for 1974 are tabulated in Table VI-16.

Because of wide diversities in travel time throughout the City's extensive collection system, the daily peak flow at Hyperion is commonly sustained for approximately 12 hours. The large volume of flow with extended peak flows and varying flow times generally precludes wide variations in such factors as pH, metals, and organohalogens. The influent to Hyperion is characteristically septic. The average flow at HTP for calendar year 1975 was approximately 352 mgd. As shown in Figure 19, the 12-month moving average steadily increased for the 18 months ending December 1975. Shown in Table VI-17 are the estimated quantities of flow for the various water agencies tributary to HTP.

b. Terminal Island Treatment Plant. Influent wastewater characteristics at the Terminal Island Treatment Plant for 1974-1975 showed an average flow of 10.6 mgd, 281 mg/l SS, and 215 mg/l BOD. The moderately high SS concentrations are most likely a result of industrial flows in the service

Table VI-12. Existing and projected flow and waste loads—Hyperion Treatment Plant.

	FLOW, mgd[1]				BOD, 1000 lb/day[2]				SS, 1000 lb/day[3]			
	1975	1980	1990	2000	1975	1980	1990	2000	1975	1980	1990	2000
1. Annual Dry Weather												
a. Domestic and Commercial	310.7	311.1	331.7	349.2	598	575	636	669	640	617	681	717
b. Industrial	31.1	31.1	33.2	35.0	132	127	141	148	146	141	156	164
c. Infiltration	10.0	10.0	10.0	10.0	-	-	-	-	-	-	-	-
d. LAGWRP Sludge[4]	0.0	1.5	1.5	1.5	0	17	19	20	0	30	33	35
e. BWRP Sludge	0.5	0.5	0.5	0.5	7	11	12	12	12	19	20	20
TOTAL	352.3	354.2	376.9	396.2	737	730	808	849	798	807	890	936
2. Maximum Monthly												
a. Domestic and Commercial	320.6	321.0	342.3	360.3	617	593	656	690	661	637	703	740
b. Industrial	32.1	32.1	34.3	36.1	136	131	146	153	151	145	161	169
c. Infiltration	10.0	10.0	10.0	10.0	-	-	-	-	-	-	-	-
d. LAGWRP Sludge[4]	0.0	1.5	1.5	1.5	0	18	20	21	0	31	34	36
e. BWRP Sludge	0.5	0.5	0.5	0.5	7	11	12	12	12	20	21	21
TOTAL	363.2	365.1	377.6	408.4	760	753	834	876	824	833	919	966
3. 5-Day, 5-Week Peak												
a. Domestic and Commercial	330.3	330.7	352.6	371.2	636	611	676	711	680	656	724	762
b. Industrial	33.1	33.1	35.3	37.2	140	135	150	157	155	150	166	174
c. Infiltration	10.0	10.0	10.0	10.0	-	-	-	-	-	-	-	-
d. LAGWRP Sludge[4]	0.0	1.5	1.5	1.5	0	18	20	21	0	32	35	37
e. BWRP Sludge	0.5	0.5	0.5	0.5	7	12	13	13	13	20	21	21
TOTAL	373.9	375.8	399.9	420.4	783	776	859	902	848	858	946	994
4. Peak Dry Weather	437.2	439.2	464.2	485.4	-	-	-	-	-	-	-	-
5. Peak Wet Weather												
a. Domestic and Commercial	387.9	388.3	411.1	430.3	837	805	890	937	896	864	953	1004
b. Industrial	38.8	38.9	41.1	43.1	185	178	197	207	204	197	218	230
c. Inflow/Infiltration	219.0	219.0	219.0	219.0	-	-	-	-	-	-	-	-
d. LAGWRP Sludge[4]	0.0	1.5	1.5	1.5	0	24	27	28	0	42	46	49
e. BWRP Sludge	0.5	0.5	0.5	0.5	10	15	17	17	17	27	28	28
TOTAL	646.2	648.2	673.2	694.3	1032	1022	1131	1189	1117	1130	1245	1311

[1] Industrial flow and combined domestic and commercial flow estimated at 9.1 percent and 90.9 percent based on permit records.

[2] From sampling and records, 18.1 percent of total BOD is contributed by industrial flows and 81.9 percent is contributed by combined domestic and commercial flows.

[3] From sampling and records, 18.6 percent and 81.4 percent of the total SS is contributed by industrial flows and combined domestic and commercial flow, respectively.

[4] Estimated sludge discharge from the 20 mgd facility anticipated to be operational in 1976.

Table VI-13. Existing and projected flows and waste loads at Terminal Island Treatment Plant.

	QUANTITY				QUALITY							
	AVERAGE DAILY FLOW, MGD				AVERAGE DAILY BOD LOAD, 1000 LB				AVERAGE DAILY SS LOAD, 1000 LB			
	1976	1980	1990	2000	1976	1980	1990	2000	1976	1980	1990	2000
ANNUAL DRY WEATHER												
1. Domestic and Commercial	7.1	9.0	9.7	10.0	18	23	24	25	19	24	26	27
2. Industrial	13.4	17.0	18.3	19.4	38	47	49	52	42	52	54	57
3. Total	20.5	26.0	28.0	29.4	56	70	73	77	61	76	80	84
MAXIMUM MONTHLY												
1. Domestic and Commercial	8.5	10.8	11.6	12.2	22	27	29	31	22	29	31	33
2. Industrial	16.1	20.4	22.0	23.1	45	56	59	62	50	62	65	68
3. Total	24.6	31.2	33.6	35.3	67	83	88	93	72	91	96	101
PEAK DRY WEATHER	37.6	47.6	51.2	53.8	-	-	-	-	-	-	-	-
				(Figures below are instantaneous loads, not daily average.)								
PEAK WET WEATHER												
1. Domestic and Commercial	13.0	16.5	17.7	18.6	33	41	44	47	34	44	47	50
2. Industrial	24.6	31.1	33.5	35.2	69	86	89	94	77	95	99	104
3. Infiltration/Inflow	9.1	9.9	10.6	11.0	-	-	-	-	-	-	-	-
4. Total	46.7	57.8	61.8	64.8	102	127	133	141	111	139	146	154

Table VI-14. Existing and projected flows and waste loads at Los Angeles-Glendale Water Reclamation Plant.

	QUANTITY	QUALITY							
	AVERAGE DAILY FLOW, MGD	AVERAGE DAILY BOD LOAD, 1000 LB				AVERAGE DAILY SS LOAD, 1000 LB			
	1976 TO 2000	1976	1980	1990	2000	1976	1980	1990	2000
ANNUAL DRY WEATHER									
1. Domestic and Commercial	18.1	27	28	29	29	33	33	34	35
2. Industrial	1.9	6	6	6	7	8	8	8	8
3. Total	20.0	33	34	35	36	41	41	42	43
MAXIMUM MONTHLY									
1. Domestic and Commercial	21.7	32	33	34	35	40	40	41	41
2. Industrial	2.3	7	7	8	8	9	9	10	10
3. Total	24.0	39	40	42	43	49	49	51	51
PEAK DRY WEATHER	38.8	-	-	-	-	-	-	-	-
PEAK WET WEATHER									
1. Domestic and Commercial	35.2	52	53	56	56	62	65	67	67
2. Industrial	3.6	12	12	12	13	15	15	15	15
3. Infiltration/Inflow	4.8	-	-	-	-	-	-	-	-
4. Total	43.6	64	65	68	69	77	80	82	83

Note: Anticipated when the 20 mgd plant becomes operational in 1976.

Table VI-15. Hyperion Treatment Plant monthly influent characteristics (fiscal year 1974-1975).

	AVERAGE FLOW (MGD)	AVERAGE SS (MG/L)	AVERAGE BOD (MG/L)	PEAK INST. FLOW (MGD)
July	349	261	260	470
August	350	267	263	460
September	344	251	245	480
October	346	255	242	460
November	339	266	243	470
December	343	283	270	480
January	342	289	259	470
February	351	278	250	490
March	354	283	255	490
April	354	270	252	480
May	349	269	252	470
June	353	297	272	475
Annual Average	348	272	255	-

Table VI-16. Hyperion Treatment Plant chemical analysis of wastewater, 1974 averages (results expressed in mg/l[1]).

PARAMETER	RAW WASTEWATER	PRIMARY EFFLUENT	SECONDARY EFFLUENT	5-MILE OUTFALL	7-MILE OUTFALL
MGD	343	343	100	388	4.7
Set. Solids	9.8	0.3	-	0.1	-
COD	567	318	34	250	-
BOD	258	171	10	121	-
SS	264	103	8	83	-
VSS%	79	82	69	80	-
TDS	939	940	700	-	854
VTDS%	22	18	16	-	61
TS	1172	1043	708	-	8400
pH	7.2	7.2	7.4	7.3	7.3
Grease	33	29	0.7	18	900
Tot. Hard	224	176	177	-	-
Phenol	0.08	0.06	0.01	0.06	-
MBAS	8.2	7.7	0.4	5.1	-
Na	205	204	127	-	-
Mg	23	24	12.6	-	-
Ca	52	51	47	-	-
NH_4-N	18	15.8	6.8	13.8	228
K	17	17.3	11.7	-	-
Al	1.07	0.68	0.23	-	-
Cu	0.36	0.22	0.05	0.19	13.9
Zn	0.58	0.34	0.14	0.24	23.9
Fe	1.87	0.69	0.18	0.64	78.7
Ni	0.24	0.20	0.13	0.18	3.1
Pb	0.08	0.05	0.01	0.04	1.13
As	0.01	0.01	0.00	0.01	0.18
Cd	0.04	0.03	0.01	0.02	1.27
Cr+6	0.00	0.00	0.00	0.00	0.00
Cr+3	0.40	0.27	0.07	0.12	15.1

Table VI-16. (continued)

PARAMETER	RAW WASTEWATER	PRIMARY EFFLUENT	SECONDARY EFFLUENT	5-MILE OUTFALL	7-MILE OUTFALL
Mn	0.02	0.02	0.02	0.02	0.19
Se	0.06	0.04	0.01	0.02	0.40
Hg	0.0059	0.0041	0.0011	0.0032	0.154
Ag	0.04	0.03	0.01	0.02	0.04
Cl	239	239	104	-	-
SO_4	143	142	132	-	-
HCO_3	291	281	226	264	-
SIO_2	19.3	20.0	16.8	-	-
PO_4	31.3	31.7	4.2	24.4	157.0
B	0.72	0.68	0.67	-	-
F	1.05	1.16	1.06	1.13	-
NO_3-N	0.2	0.2	2.3	0.3	-
NO_2-N	0.00	0.00	0.4	0.00	-
CN	0.27	0.28	0.06	0.20	0.53
TICH[2]	0.0018	0.0017	0.0005	0.0014	0.0074
Sp. Cond.	1547	1549	1050	1530	2880
Ba	0.74	0.39	0.04	-	-
Organic N	14.28	7.9	1.6	6.3	-

[1] Flow, Settleable Solids, Volatile Total Dissolved Solids, Volatile Suspended Solids, pH, Specific Conductivity excepted.

[2] Total Identifiable Chlorinated Hydrocarbons.

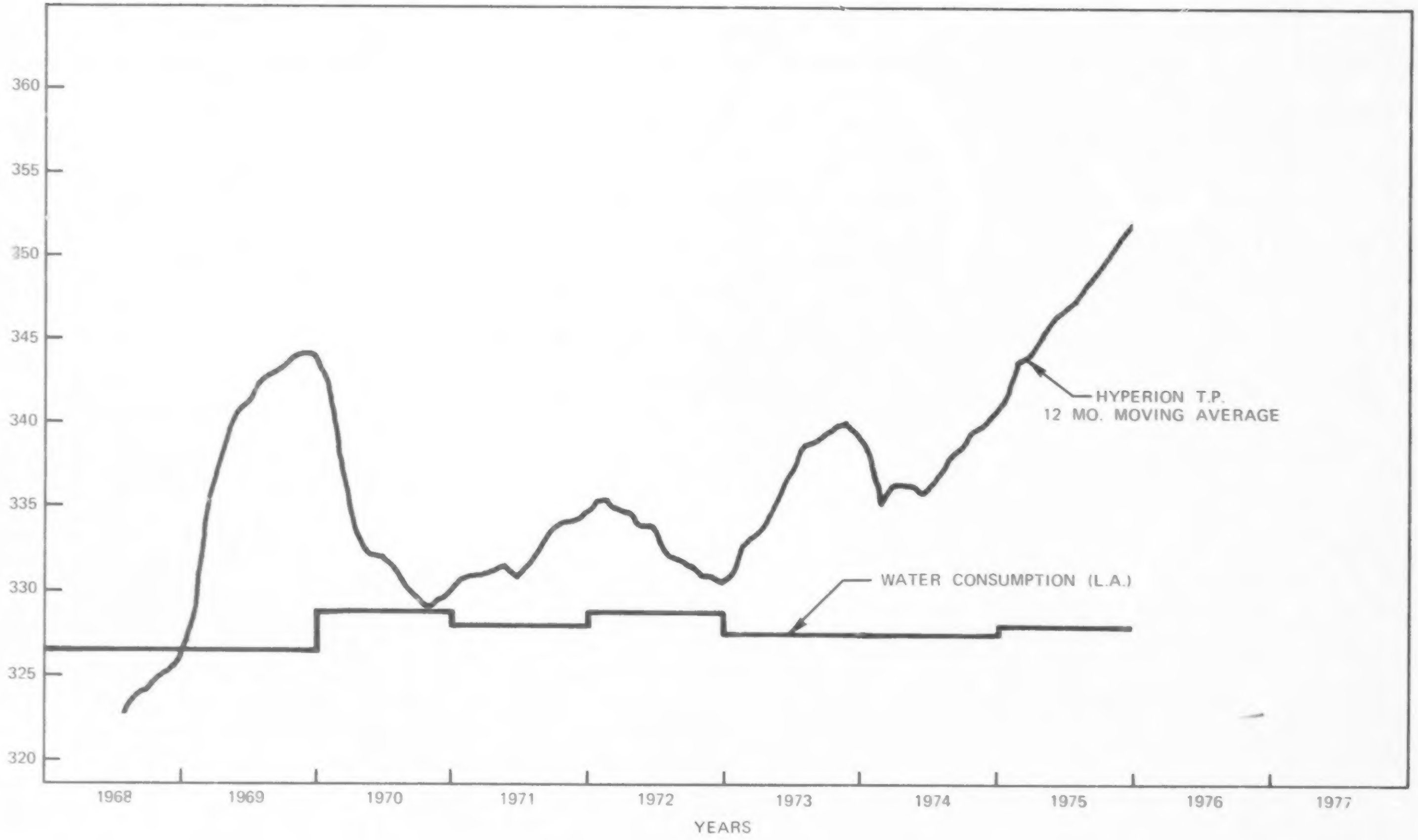

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Figure VI-19. Hyperion Treatment Plant 12-month moving average (influent flows).

Table VI-17. Estimated quantities of flow from different water agencies tributary to Hyperion Treatment Plant.

SEWER AGENCY	WATER AGENCY AND WATER SOURCES*	AVERAGE SEWAGE FLOW TO HYPERION (MGD)	AGENCY SOURCE WATER MIX LOCAL (%)	AVERAGE AGENCY MIX AT HYPERION (%)	AVERAGE SOURCE MIX AT HYPERION (%)
City of Los Angeles	City of Los Angeles	278.8		82.8	
	Owens River Aqueduct		82		67.9
	Groundwater (LA River Supply)		14		11.6
	MWD		4		3.3
City of Beverly Hills	City of Beverly Hills	6.4		1.9	
	Groundwater		30		0.6
	MWD		70		1.3
City of Burbank	City of Burbank	6.9		2.0	
	Groundwater		59		1.2
	MWD		41		0.8
City of Culver City	So. Cal. Water Service	4.6		1.4	
	MWD		90		1.3
	Groundwater		10		0.1
City of El Segundo	City of El Segundo	2.0		0.6	
	MWD		100		0.6
City of Glendale	City of Glendale	16.1		4.8	
	MWD		38		1.8
	Groundwater		82		3.0
City of San Fernando	City of San Fernando	1.6		0.5	
	MWD		4		0.0
	Groundwater		96		0.5
City of Santa Monica	City of Santa Monica	11.1		3.3	
	MWD		59		1.9
	Groundwater		43		1.4
CSD 2*	Cal Water Service	1.3		0.4	
	MWD		60		0.2
	Groundwater		40		0.2
CSD 4	Serviced app. ½ by City of LA and ½ by City of Beverly Hills	4.2		1.5	
	Owens River Aqueduct		50		0.8
	Groundwater (Beverly Hills)		15		0.2
	MWD (Beverly Hills)		35		0.5
CSD 5 and 11	Cal American Water Co.	0.7		0.2	
	MWD		50		0.1
	Groundwater		50		0.1
CSD 16	Cities of So. Pasadena and Alhambra	0.4		0.1	
	Groundwater		100		0.1
CSD 27	Waterworks District No. 29	0.2		Negligible	
	MWD		100		0.0
County of LA (Marina del Rey)	Waterworks District No. 29	1.0		0.3	
	MWD		100		0.3
"Hughes Island"	So. Cal. Water Service	0.3		0.1	
	MWD		90		0.1
	Groundwater		10		
Veteran's Admin. (Sawtelle)	City of Los Angeles	0.4		0.1	
	Owens River Aqueduct		100		0.1
	TOTALS	336.7		100.0	100.0

*Effective January, 1976, no longer tributary to the Hyperion Treatment Plant.

Note: Table does not show agencies with flows of 0.1 mgd or less.

area. BOD quantities appear to be of medium strength. The average 1975 TDS for TITP influent was 2,735 mg/l.

The unusually high TDS level at the TITP has been attributed to seawater infiltration in the collection system and, to a lesser extent, oil brine discharges. Contribution to the high TDS level due to oil brine discharges should cease in 1976 as the policy of water flood oil recovery will be in full operation.

The industrial component of influent to the TITP was estimated at 16 percent in fiscal 1972-1973. However, with the imminent completion of both the collection system and the expanded facilities now under construction, the industrial component is expected to constitute more than 60 percent of the plant influent.

D. pollution and source control

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D. POLLUTION AND SOURCE CONTROL

1. POLLUTION SOURCES

Preliminary to taking appropriate corrective measures in attempting to achieve the water quality objectives expressed in Chapter IV, sources of pollution must be identified. Ground and surface water pollution sources are basically two types: point and non-point. The most obvious controllable point sources of pollution to receiving waters are residential and industrial wastewaters (including power plants) and those municipal wastewater systems which collect them and discharge treated effluent directly or indirectly into coastal waters or groundwater basins. Non-point sources of various wastes include mining, construction, and agricultural activities; aquatic vessel wastes; solid waste disposal area runoff; seawater intrusion; atmospheric fallout; and storm runoff. These potential pollution sources are quantified and evaluated in Chapter III or in the Facilities Plan.

2. EFFLUENT WASTEWATER CHARACTERISTICS

a. Municipal Wastewater Systems.

(1) HYPERION TREATMENT PLANT. Effluent from Hyperion may reach the ocean from all three of its submarine outfalls. The majority of the normal operation effluent is discharged through the five-mile outfall with the seven-mile outfall carrying the sludge mixed with a comparatively small amount of effluent from the plant's treatment facilities. The original Hyperion outfall (12-foot diameter, one-mile) is used on those rare occasions of peak wet-weather flows exceeding 630 mgd at which time chlorinated effluent from the secondary treatment process is diverted to this standby outfall.

Typical of flow conditions at Hyperion are data obtained in fiscal year 1971-1972. During that year, the greatest dry-weather peak flow was 600 mgd, the greatest wet-weather peak flow was 620 mgd, and the greatest dry-weather average flow was 367 mgd. The results of effluent analysis of the Hyperion effluent for 1974 are indicated in Table VI-18, and the mass emission rates are shown in Table VI-19.

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Table VI-18. Average concentrations of general constituents, trace metals, and chlorinated hydrocarbons, in the final effluent of Los Angeles City municipal waste dischargers for 1974 (SCCWRP, 1975a; DPW, 1975a).

CONSTITUENT	HYPERION		TERMINAL ISLAND
	5-MILE	7-MILE	
Flow (mgd)	341	4.72	10.3
General Constituents (mg/l)			
Total Suspended Solids	83	7,300	151
Volatile Suspended Solids	66	4,700	—
5-day BOD	121	1,900[1]	159
Chemical Oxygen Demand	250	7,700[1]	342
Oil and Grease	18	900	22
Nitrate Nitrogen	0.3	—	0.3
Ammonia Nitrogen	13.8	300[1]	20.9
Organic Nitrogen	6.3	250[1]	9.4
Total Nitrogen	20.4	550[1]	30.6
Total Phosphate	24.3	663[1]	34.0
Detergent (MBAS)	5.1	—	9.2
Cyanide	0.2	0.53	0.11
Phenols	0.06	—	0.07
Trace Metals (mg/l)			
Silver	0.02	0.40	0.02
Arsenic	0.01	0.18	0.01
Cadmium	0.02	1.27	0.01
Chromium	0.21	15.1	0.20
Copper	0.19	13.9	—
Iron	0.64	78.7	0.88
Mercury	0.0032	0.15	0.0044
Manganese	0.02	0.19	0.03
Nickel	0.18	3.1	0.27
Lead	0.04	1.13	0.07
Selenium	0.02	0.40	0.19
Zinc	0.24	23.9	0.36
Chlorinated Hydrocarbons (μg/l)			
Total DDT	0.12[2]	2.59	
Total PCB	0.35[3]	122[3]	0.0013[4]
Dieldrin	0.01	0.17	

[1] Based upon analysis of 10 weekly composites

[2] Calculated from mass emission rate of Table VI-19 (SCCWRP data). The HTP value was 0.72 μg/l.

[3] These values were determined independently by SCCWRP (Young et al., 1975, page 5) and are similar to the HTP values for the 5-mile effluent but substantially higher (122 μg/l compared with 3.3 μg/l) for the 7-mile effluent. Young (personal communication, 23 June 1975) believes that his data are correct, and that HTP's data underestimated the actual concentrations.

[4] Total identifiable chlorinated hydrocarbons.

Table VI-19. Mass emission rates of general constituents, trace metals, and chlorinated hydrocarbons in the final effluent of Los Angeles City municipal waste dischargers for 1974 (SCCWRP, 1975a; DPW, 1975a).

CONSTITUENT	HYPERION		TERMINAL ISLAND
	5-MILE	7-MILE	
Flow (mgd)	341	4.72	10.3
General Constituents (metric tons/yr)			
Total Suspended Solids	39,100	47,500	2,148
Volatile Suspended Solids	31,100	30,600	—
5-day BOD	56,900	12,400	2,263
Chemical Oxygen Demand	118,000	50,200	4,867
Oil and Grease	8,470	5,860	313
Nitrate Nitrogen	141	—	4.3
Ammonia Nitrogen	6,490	1,950	297
Organic Nitrogen	2,960	1,628	134
Total Nitrogen	9,600	3,580	436
Total Phosphate	11,400	4,320	484
Detergent (MBAS)	2,400	—	131
Cyanide	94.1	3.45	1.6
Phenols	28.2	—	1.0
Trace Metals (metric tons/yr)			
Silver	9.41	2.61	0.29
Arsenic	4.71	1.17	0.14
Cadmium	9.41	8.27	0.14
Chromium	98.8	98.4	2.85
Copper	89.4	90.5	—
Iron	301	513	12.5
Mercury	1.51	0.98	0.06
Manganese	9.41	1.24	0.43
Nickel	84.7	20.2	3.84
Lead	18.8	7.36	1.0
Selenium	9.41	2.61	2.7
Zinc	113	156	5.1
Chlorinated Hydrocarbons (kg/yr)			
Total DDT	56[1]	17[1]	
Total PCB	160[1]	790[1]	0.019[2]
Dieldrin	4.71	1.11	

[1] These data are from an independent analysis of DDT and PCB in the Hyperion Effluent by SCCWRP (1975a, page 106). The mass emission rates of DDT calculated by HTP at the 5-mile outfall are 6 times those calculated by Young, et al., but are identical at the 7-mile outfall. The total PCB emission rates calculated by Young, et al. are similar to the HTP calculations at the 5-mile outfall, but are 37 times those calculated by HTP at the 7-mile outfall.

[2] Total identifiable chlorinated hydrocarbons.

(2) TERMINAL ISLAND TREATMENT PLANT. The existing Terminal Island Treatment Plant provides only primary treatment for a design capacity, average daily flow of 14 mgd. Treated effluent is discharged into Outer Los Angeles Harbor, and the effluent characteristics for 1974 are indicated in Table VI-18. The mass emission rates are shown in Table VI-19.

The existing facility is presently being upgraded with a new facility having a design capacity of 30 mgd and providing secondary biological treatment for all wastewater entering the plant. This new facility, combined with the completion of the Harbor Sewerage Collection System, will drastically change the character of wastewater in the Harbor area.

(3) LOS ANGELES ZOO TREATMENT PLANT. The plant serving the Los Angeles Zoo in Griffith Park provides primary treatment of animal wastes from animal ponds and the daily wash down of animal exhibit areas. The plant has a design capacity of 2.5 mgd and during dry weather treats all animal waste from the zoo. Suspended solids are removed by primary sedimentation and the sludge is pumped to the City's sewer system. The remainder of the effluent is chlorinated and discharged to the Los Angeles River near the Colorado Street Bridge. During wet-weather flows in excess of plant capacity, part of the wastewater from the animal exhibit areas, diluted with storm runoff, flows untreated into the river.

The obvious deficiency of the treatment plant to accommodate peak wet-weather flows thereby discharging untreated wastewater into the Los Angeles River is somewhat mitigated by the dilution rate achieved in the mixing with storm runoff. A major deficiency does exist, however, due to the lack of sufficient standby equipment in case of a breakdown in existing equipment. During even minor storm runoffs, the storm drain system serving the zoo and surrounding hills carries a considerable amount of disintegrated granite which in the past has caused both the clarifiers in the plant and the forced sludge main to clog. The disintegrated granite can also cause considerable wear on the pumping system and could cause the pump to shut down. Due to any one of these possible situations, and as has happened in the past, raw untreated sewage is discharged into the Los Angeles River.

On December 12, 1974, the California Regional Water Quality Control Board-Los Angeles Region adopted Order No. 74-566 relative to wastewater discharges from the Los Angeles Zoo. This order serves as a NPDES permit and provides for the control of the Los Angeles Zoo facilities to assure compliance with the Interim Water Quality Control Plan objectives for the Los Angeles River. The permit establishes certain effluent limitations, requires comprehensive sampling and laboratory analysis, and monthly monitoring reports on the quality of the effluent and the Los Angeles River downstream from the point of discharge.

(4) VALLEY SETTLING BASIN. The Valley Settling Basin near Griffith Park was originally constructed in 1954 as a storage regulation facility to provide hydraulic relief for the North Outfall Sewer. The urgency for

such relief was realized in 1953 when raw sewage overflowed into the Los Angeles River and City streets due to the backed-up pressure flow in the North Outfall Sewer and upstream tributary sewer systems. In fiscal year 1954-1955, an average flow of 9.2 mgd was diverted from the NOS into the plant where the influent was treated, chlorinated and discharged into the Los Angeles River.

After completion of relief sewers, use of the Valley Settling Basin on a regular basis to level off excessive peak wastewater flows downstream was not necessary. It has since been put out of service as a storage regulation facility and is presently used as an experimental water reclamation plant and training facility.

Currently, there are no discharges from the Valley Settling Basin into the Los Angeles River. The experimental facility is an activated sludge facility with a design capacity of one mgd. Influent is received from the NOS and the primary and waste activated sludge effluent is returned to the NOS. The reclaimed water effluent is used in various experiments. This facility, as presently operated, is not then a direct source of pollution to receiving waters.

(5) NOS OVERFLOW TO BALLONA CREEK. There are several situations in the City's sewer system where sewage may overflow into adjoining watercourses because of a lack of capacity of the sewer system to handle peak wet-weather flows. Most of these situations occur in the form of overflow pipes in the inlet structures of various inverted siphons that cross under the Los Angeles River. These situations generally involve small quantities of overflow on rare occasions. Another situation exists, however, in the NOS in Culver City where significant quantities of sewage overflow may occur.

A major emergency bypass for the North Outfall Sewer (NOS) exists at Jackson Avenue northerly of the intersection of Overland Avenue and Jefferson Boulevard. This structure is available in case of problems downstream, either by stoppage or breakage of the NOS or a shutdown of facilities at Hyperion Treatment Plant. If such an emergency situation arises, the wastewater flow to the NOS can be shut off by a manually operated gate with the flow diverted to Ballona Creek after chlorination. This emergency bypass structure has not been used since its construction in 1965.

Another structure in the near vicinity of the emergency bypass is an overflow structure which was constructed in the mid-1950s. This structure provides hydraulic relief for the NOS by automatically permitting the overflow of some of the peak flows which have been experienced in the past. Excess pressure in the NOS automatically causes the structure to overflow. After chlorination, wastewater spills down the sloped embankment of the trapezoidal channel of Ballona Creek. Wastewater flow reaches the overflow structure either directly through an opening in the West Los Angeles Interceptor Sewer which abuts the overflow structure or through a portion of an abandoned 3-pipe siphon which formerly passed under Ballona Creek.

In the past the overflow structure has been used intermittently as the need arose, usually once or twice a year. The necessity for more frequent use of the overflow structure was alleviated with the construction of upstream relief sewers. Accurate records of the flows from the structure were first recorded in 1965 and are tabulated in Table VI-20. The results of a hydraulic analysis of the inflow and outflow sewers tributary to the structure for the storm of January 7, 1974 are depicted in Table VI-21 and indicate that the probable maximum overflow that can occur is in the order of 110 to 120 mgd. A comparison with the actual recorded overflow on January 7, 1974, indicates that this conclusion is reasonably accurate. Although the flow rates shown in Tables VI-20 and VI-21 may appear to represent tremendous volumes of wastewater overflow into Ballona Creek, the actual parameter of interest with respect to impact is the total flow based on the duration at the overflow. From Table VI-20 it can be seen that the maximum recorded duration of overflow occurred on January 7, 1974 and resulted in the total overflow of 37 million gallons. It is also significant to recognize that overflows have occurred during a storm period when large quantities of storm water have resulted in a diluted overflow and rapid transportation downstream in Ballona Creek to the ocean; however, the environmental impacts of such relatively untreated wastewater are of concern and are treated in Chapter VIII Primary Impacts. Overflows must be permitted under NPDES, and if not secondary treated, must be eliminated or treatment provided by July 1, 1977.

Table VI-20. Recorded flows from Jackson Avenue overflow structure.

DATE	PEAK FLOW MGD	FLOW DURATION HOURS	TOTAL FLOW MG
November 22, 1965	16	1.7	—[3]
December 29, 1965	102	5.0	16.3
November 7, 1966	6	2.5	—[3]
November 21, 1967	8	1.5	—[3]
November 22, 1967	—[1]	3.2	—[3]
January 25, 1969	—[2]	—[2]	—[2]
February 23, 1969	14	4.5	1.9
November 29, 1970	126	7.0	21.1
December 24, 1971	30	1.7	—[3]
January 7, 1974	116	15.4	37.0

[1] No record due to power failures; 40 MGD peak estimated visually.

[2] No record; apparently peak flow was very small.

[3] Insufficient data to calculate.

Table VI-21. Flow balance of sewers at Jackson Avenue overflow structure; storm of January 7, 1974.

NAME OF SEWER	FLOW RATE (CFS)	FLOW RATE (MGD)
INFLOW:		
NOS (serves Hollywood and San Fernando Valley), full flow	450	291
Westwood Relief Sewer, full flow[1]	119	77
West Los Angeles Interceptor Sewer, full flow[1]	76	49
Total inflow apparently possible	645	417
OUTFLOW:		
NOS[2]	480	310
Overflow structure	172[3]	111[3]
Total Overflow Occurring	652	421

[1] Full flow Qs are essentially the maximum possible inflows as controlled by terrain configuration and pipe hydraulics.

[2] This is greater than full flow. Flow occurring was determined from flow records at HTP headworks which indicate that sewer is under limited pressure. Full flow "Q" is 446 cfs (288 mgd).

[3] Apparent maximum possible overflow at Jackson Avenue.

E. effects of source control programs on effluent quality

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E. EFFECTS OF SOURCE CONTROL PROGRAMS ON EFFLUENT QUALITY

The City of Los Angeles source control programs described in Section VI.D.1 and Appendix V.C were designed to reduce the load of toxicants in the influent to Hyperion Treatment Plant to aid in reducing the effluent concentrations of these substances to within the State and Federal discharge requirements. These programs apply only to industrial discharges to the sewer system which, however, contribute a large proportion of most of the toxicants in the raw HTP influent (See Table VI-22) while contributing only 19 percent of the volume (DPW, 1973). Domestic wastewater, however, contributes most of the arsenic, cadmium, and lead. The arsenic may come from the domestic water supply, but the sources of the high levels of cadmium and lead remain unexplained (DPW, 1973).

The percent reductions in the discharge of toxicants to the sewers that could be achieved by industries through an extended source control program are also shown in Table VI-22. Most of the substances can be reduced substantially with the notable exception of arsenic (domestic source) and mercury (from hospitals). These substances are also reduced to various degrees by the current wastewater treatment procedures at HTP (Table VI-22), and conversion to full secondary treatment at HTP will further reduce the effluent concentrations of these substances.

The effects of industrial source controls on the effluent resulting from various levels of treatment are shown in Figure VI-20 for 1974 and predicted full secondary HTP treatment capabilities. It is apparent that even with full secondary treatment, source controls will be required to reduce the concentrations of most constituents to within the California State standards. Only chromium and mercury would probably not meet the standards if maximum source controls were enforced while nickel and cyanide, too, would not meet the standards with full secondary treatment and no source controls. Even with source controls and full secondary treatment mercury and chromium are not expected to meet the state standards. The major source of mercury is hospitals, and implementation of source controls there may reduce the quantity in the HTP influent sufficiently to meet the standards after treatment. For chromium, however, full secondary treatment plus enforced 90 percent source control would result in an effluent concentration of 0.023 mg/l, which exceeds the standard of 0.005 mg/l by about a factor of four. Even if industrial discharges were totally eliminated, the effluent would contain 0.0099 mg/l of chromium and would still exceed the state standards.

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Table VI-22. The percentage of wastewater constituents in the Hyperion Treatment Plant influent contributed by industrial discharges to the sewers, the percent reduction in the amount discharged by industries using the best practical technology available for source controls, and the percent reduction that would occur in these substances from HTP treatment processes for the 5-mile effluent in 1974 and with full secondary treatment (DPW, 1973 and 1975a; Hoeptner, December 23, 1976).

CONSTITUENT	% CONTRIBUTED BY INDUSTRY[1]	% REDUCTION IN THE INDUSTRIAL EFFLUENT POSSIBLE BY SOURCE CONTROL[2]	% REDUCTION IN THE CURRENT HTP FINAL EFFLUENT (5-MILE OUTFALL)	% REDUCTION BY HTP SECONDARY TREATMENT[3]
As	19	0	0	50
Cd	19	80	50	33
Cr (total)	93	90	48	70
Cu	85	90	47	75
Pb	19	80	50	63
Hg	67	10	46	50
Ni	79	86	25	33
Ag	55	60	50	41
Zn	67	87	59	65
CN	98	95	26	52
Phenol	42	50	25	75

[1] Most comes from metal finishing with the exception of As (source unknown), Hg (hospitals), Ag (film processing), and phenols (cooling towers)(DPW, 1973).

[2] Reduction possible by best practical technology (DPW, 1973).

[3] Calculated from HTP predicted influent and effluent characteristics (Hoeptner, December 23, 1976). Some of these data appear inconsistent, for example the current lack of reduction of As in the 5-mile effluent, but 50 percent reduction from secondary treatment. The inconsistencies occur because the constituent concentration data were usually rounded off to two decimal places. Reduction by secondary treatment is normally considered higher because most metals are attached to suspended solids. This data will be revised for the final.

NOTE: Domestic wastewater contributes a large proportion of the As, Cd, and Pb. Several strictly residential areas were sampled by the city during November 1975 through January 1976 to verify this. Each location was sampled twice to check the repeatability of the analysis (DPW office memorandum, February 23, 1976).

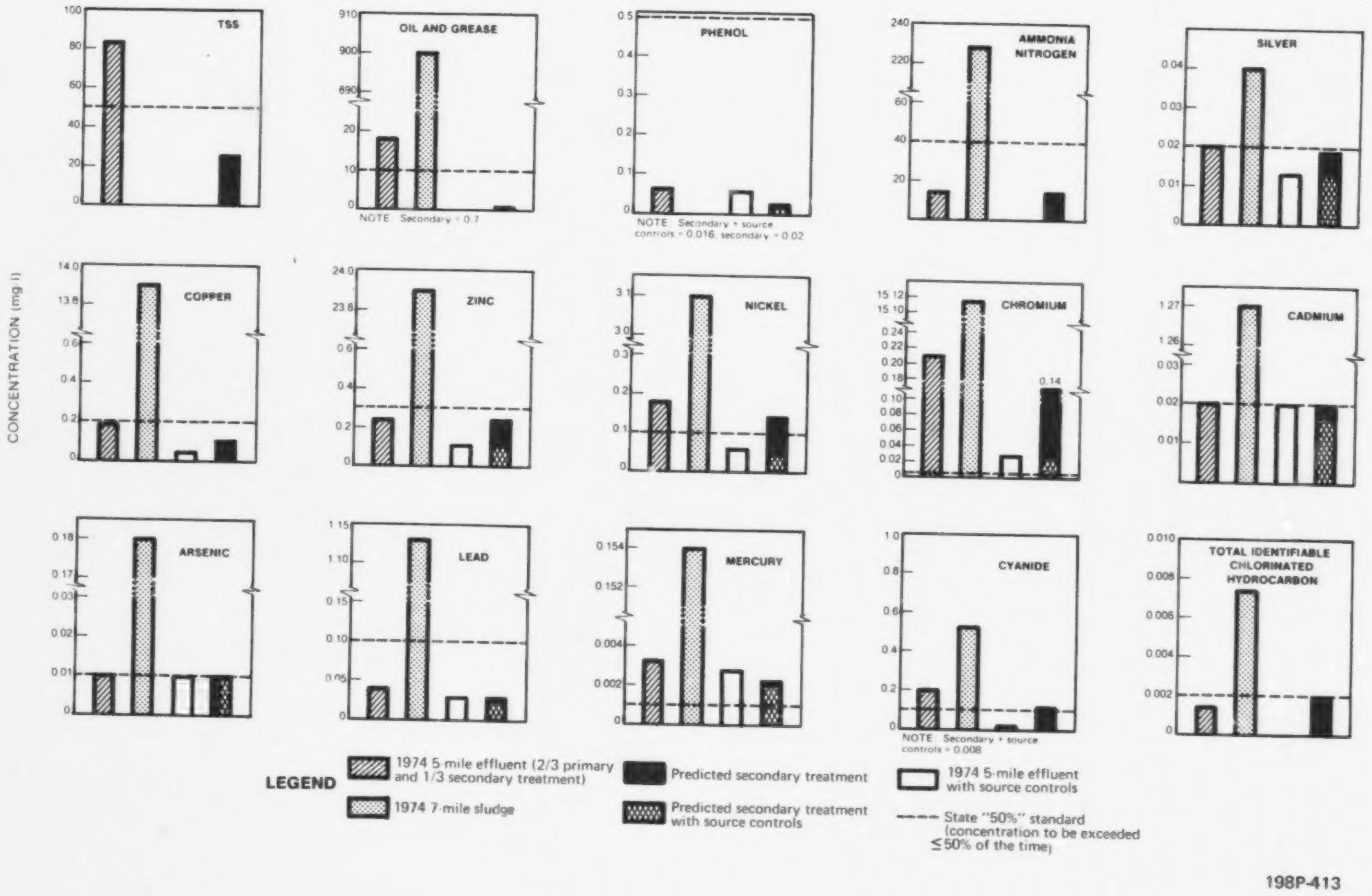

Figure VI-20. The effects of industrial source controls on the effluent resulting from various levels of treatment for 1974 and predicted full secondary HTP treatment capabilities.

NOTE: A comparison of the annual average concentration with the state standard to be exceeded $\leq$ 50 percent of the time may not represent an accurate assessment of whether the discharge is meeting the standard if the concentration in the discharge does not have a normal distribution about the mean.

The effluent concentrations with source controls were calculated from 1974 and predicted future influent characteristics as follows:

mass emissions from industry after source controls =

$$Ci\ Vi\ I\ (1 - R_I)$$

mass emissions from other sources = $Ci\ Vi\ (1 - I)$

HTP influent concentration with source controls =

$$\frac{Ci\ Vi\ (1 - R_I) + Ci\ Vi\ (1 - I)}{Vi} = Ci\ (1 - IR_I)$$

HTP 5-mile effluent with source controls =

$$Ci\ (1 - IR_I)(1 - R_T)$$

where Ci = HTP influent concentration without source controls, Vi = HTP influent volume, I = fractional amount of constituent contributed by industrial sources, R_I = fractional decrease possible with source controls, and R_T = fractional decrease possible with HTP treatment processes.

The concentration of chlorinated hydrocarbons (such as DDT and PCBs) in the influent cannot be controlled by a source control program, since no industrial point sources have been located for PCBs and no industrial discharges are known for DDT (DPW, 1973).

Illegal disposal of spent solutions to the sewers is suspected to be the major source of heavy metals in the Hyperion influent. This practice should be reduced as a result of state requirements for the certification of industrial waste haulers and requests for proof of satisfactory disposal from the industries (DPW, 1973).

In addition to effects on the concentration of constituents in the sewer system, source control programs can influence the flow discharged to the sewers. A reduction in flow could result from the conservation or recycling of solutions, alternate disposal of concentrated wastes, reduced spillage, and more efficient plant operation.

The implementation of source controls will have an economic effect, particularly on small industries such as metal finishers. These companies will need an estimated average of $40,000 each to comply with the 1977 local regulations. Metal finishing shops in Los Angeles generally employ 10 to 20 men per shop, and have gross incomes of at least $1,000/man per week. Based on 50 work weeks per year, the gross income for these shops is $500,000 to $1,000,000. The net income is estimated at approximately 10 percent; thus, 40 to 80 percent of the annual net income could be necessary to comply with the 1977 source control regulations. Shops with fewer than 10 employees do not have to meet the stringent standards that the larger (more than 11 employees) shops do, except for cyanide, so that costs may not be prohibitive for them.

The cost can be spread out over several years if the industries invest in the equipment necessary gradually or if long-term loans are available. A new amendment (S.2498) to PL 94-305 has been enacted by Congress which enables small businessmen to acquire tax-exempt financing for pollution control and waste management equipment.